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PART VIII
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HIGH TEMPERATURE ANTIOXIDANTS FOR SYNTHETIC BASE OILS

PART VIII. EVALUATION OF ANTIOXIDANTS IN SYNTHETIC FLUIDS

JAMES W. COLE, JR.

UNIVERSITY OF VIRGINIA

FEBRUARY 1958

WRIGHT AIR DEVELOPMENT CENTER

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FEBRUARY 1958

MATERIALS LABORATORY
CONTRACT No. AF 33(616)-3234
PROJECT No. 7731

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Carpenter Litho & Prtg. Co., Springfield, O.
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FOREWORD

This report was prepared in the Cobb Chemical Laboratory, University of Virginia, under USAF Contract AF 33(616)-3234. This contract was initiated under Project No. 7331, "Hydraulic Fluids", Task No. 73313, "Hydraulic Fluids". It was administered under the direction of the Materials Laboratory, Directorate of Laboratories, Wright Air Development Center, with Mr. George Baum acting as Project Director.

This report covers work conducted from October 1956 to October 1957.

ABSTRACT

This is a continuation of a laboratory program on the evaluation of the oxidation patterns of synthetic fluids in the presence and absence of inhibitors and metals in the temperature range 400°-700°F. Two methyl chlorophenyl silicones, F-50 and F-60 were examined at 500°F and 600°F. N,N'-di-2-naphthyl-p-phenylenediamine in 0.1 - 0.2% was the most interesting additive. Work with a mineral oil, MLO 57-30, did not reveal additives of outstanding activity. Substances containing sulfur and selenium showed promise, but some attack on silver and copper. The experiences with four tetra-substituted silanes showed that these substances did not have outstanding response to additives. A series of runs with a pentaerythritol ester, MLO 55-584, indicate that ring substituted aryl amines have considerable antioxidant activity over the range 400°-500°F. Some additional data for bis-(2-ethylhexyl) sebacate are included to compare the promising amines with the phenothiazine type. The former retain the inhibition of activity over a wider temperature range. Some attention was given to determining the nature of the components in an oxidized diester which contributes to the acidity. It appears that some improvement may be achieved in a partial oxidized fluid by washing with hydrocarbon solvents. The limitations of a laboratory test procedure are discussed, especially with respect to the evaluation of the effects of the test metals, aluminum, silver, copper, titanium and several steels.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

R. T. Schwartz

R.T. SCHWARTZ
Chief, Organic Materials Branch
Materials Laboratory

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HIGH TEMPERATURE ANTIOXIDANTS FOR SYNTHETIC BASE FLUIDS.

A. Introduction.

The work in this report is a continuation and expansion of the work initiated originally under Contract AF 33(038)-22947 in the Department of Chemistry, University of Virginia. Under this contract a survey was made and a technical report was prepared on the pertinent literature. An experimental procedure was devised for comparing the oxidative behavior of blends of fluids containing about 300 selected additives in the presence and absence of metals. Particular attention was given to elucidating the antioxidant behavior in the temperature range 204°-260°C (400°-500°F) of phenothiazine, its derivatives and typical compounds representing both organic and inorganic substances. The oxidation medium included the following types of synthetic fluids: esters, silicates, silicones and phosphates. The pertinent WADC technical reports and publications are listed in the bibliography.

The work reported in Part VII of this series and continued herein was under Contract No. AF 33(616)-3234. It is a continuation of the program under the former contract and was initiated 1 October 1955 to determine the oxidation pattern of additional selected additives in various new synthetic fluids, and to extend the oxidations in the promising systems to higher temperatures. In Part VII some exploratory oxidation runs with silicones and silanes were reported at temperatures as high as 370°C (700°F). Several additive systems were shown to have promise at the higher temperatures. In Part VIII more attention was given to intermediate temperatures with the view of obtaining information which might be used for recommending blends for engine tests.

The oxidation procedure was essentially the same as previously described in detail. The fluid in a Pyrex brand test cell with glass fittings was heated in an aluminum block, thermostatted furnace while dry air or a gas mixture of 95 % nitrogen and 5 % oxygen was passed through the fluid in a tube inside the overhead condenser and extending to the bottom of the test cell. In most runs, the test metals consisted of aluminum, copper, silver, titanium and one of several steels. The metals were polished washers mounted on the air tube with 3/8 inch glass spacers. For all of the cases reported herein, the volume of fluid was 25 milliliters and the gas flow was one liter per hour. In many of the earlier evaluations, a larger test cell holding 100 milliliters of fluid with a gas flow of five liters per hour was employed. The results were not strictly comparable; but, when examined in light of the behavior of a controlled blend, it is possible to correlate the behavior of the various additive systems.

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The original problem was to change the properties of a fluid by additives so that after a known period of oxidation at a given temperature the viscosity change, the acid accumulation, and the effects of the test metals would meet described specifications. The blend selected as a basis for comparison of other systems was 1% phenothiazine in bis-(2-ethylhexyl) sebacate (Plexol 201). While oxidation runs without additives have some value as blanks, there are enough sources of error in the procedure to cause considerable variation in the behavior of the uninhibited fluid. The accumulation of acids in a blank fluid was such that the neutralization number appears to approach a maximum. The air delivery tubes are subject to clogging as solid matter is formed and the viscosity increases. Even with a blend as the blank the experimental procedure still left much to be desired when small differences in behavior of the additive are to be interpreted in terms of recommendation for engine uses. The writer has very little knowledge of how the laboratory tests correlate with the next step in the development of a fluid, but it appears that additional attention is needed for better ways of evaluating additive systems in the laboratory if the purpose is to select the optimum blend on the basis of small differences.

In some other studies, designed to elucidate the mechanism of antioxidant action, it appeared that those additives, which were most active in inhibiting or retarding oxidation, gave rise to products which become insoluble in the fluid ahead of the loss of effectiveness or the end of the induction period. It also appeared that by treatment with solvents some of the oxidized products could be removed and the acidity of the fluid lowered.

The problem of evaluating the effects of metals is very difficult. An attempt was made to express the quantitative effect of metals in the form of change in weight of the test metals during an oxidation run. It should be emphasized in reporting the metal weight change in mg/cm^2 that the effects are magnified. This arises because the weight differences in the test specimens were determined on an analytical balance to about one-tenth milligram and then multiplied by a factor. Considerable inconsistences in the results arose from the method of handling the test metals after an oxidation run. First, the metal was washed with benzene and acetone. If this did not remove the film from the oxidized metal, the surface was rubbed somewhat stronger with tissue, and then with fine glass wool, with the view of removing only the surface film. However, it was observed that different operators apply varying pressure to the metal surface when trying to remove a film of oxidized fluid or additive. With silver and copper these effects are practicularly troublesome and at times some of the metal seemed to be removed with the tissue. In the interpretations the data showed that silver was not generally appreciably attacked by the amine-type additive, and the copper was only slightly attacked when the weight loss was reported in the neighborhood of 0.5 mg/cm^2. The main conclusion from the presence of metals, when the changes are of small order, was that some metals have catalytic action at least for a portion of the oxidation. However,

account must be taken of the cases where metals, especially copper, appear to enhance the antioxidant activity of some additives, particularly aryl amines.

The quantities of additives employed were usually molar equivalent weights based on the formula of phenothiazine as the standard. For example, 0.25 grams of phenothiazine in 25 ml was approximately one per cent by weight, and 0.27 grams was the same number of moles of 10-methylphenothiazine. In all reports the relative effects of antioxidants, inhibitors and oxidation retardants, it is strongly recommended that molar equivalent quantities be used as a basis for comparison. In preparing a mixture for an oxidation run, the ability of the fluid to form a homogeneous system with the additive was noted. Since the molar equivalent quantities of substances were being compared, the run was performed even though all of the additive did not dissolve at room temperature or on heating on the water bath. In practically all cases with effective additives these systems became homogeneous at the oxidation-test temperature.

In comparing the behavior of additives when the view is to select the best system, all of the data must be considered to show subtle differences. A scheme was devised for the comparison of additives in which an index number represents the summation of various property changes. While convenient in some instances the method has limitations. The behavior of volatile acid products sometimes appeared to lower the value of the index number and to give the impression of a better system than was the case. In order to show all effects of oxidation of a blend all of the significant data for each of the fluid systems examined during the past year are tabulated under each fluid. An effort is made to point out the more promising systems in the discussion sections that follow. This involves some subjective analysis as well as the intuition of the writer in some instances.

A page index to the runs for the various additives for Parts VII and VIII of the technical report series is given in Appendix I. Also included are the sources of the additives and fluids. At this point, some explanation on the purity of additives is needed. For those substances obtained through commercial sources, where the purity was not equivalent to Eastman Kodak White Label, the substances were further purified by appropriate crystallization, sublimation or distillation. For materials obtained through WADC channels the substances were used as received. The effect of the purity of additives is interesting. For the phenothiazine type it appeared to make little difference whether a highly purified sample was used. For some of the amines, the higher the purity the better the effectiveness. This aspect is being continued as a problem under another type of support.

In the following section these fluids were new during the current contract year and experiences with them are reported for the first time: A naphthlenic mineral oil, MLO 57-30, two methyl chlorophenyl silicones, F-60 and F-50, didodecyl dioctyl silane, MLO 57-161,

and *n*-octadecyl-tri-*n*-octyl silane, MLO 56-578.

Some experiences with the other fluids have been previously reported, but the tabulated data represents new work with the system, either for purposes of establishing blanks or for comparing additives under new conditions.

B. Oxidations in Mineral Oil, MLO 57-30.

This is the first account of experiences with a mineral oil. This fluid was suggested for evaluations by the Materials Laboratory, Wright Air Development Center. Presumably it is of naphthenic base and is designed for use at temperatures in the neighborhood of 500°F. It exhibited considerable inherent stability at this temperature. While no additive was dramatic in action several retarded the increase in viscosity. Those of some promise include: diphenyl sulfide, phenothioxine, diphenyl selenide, 2,2'-dibiphenyl diselenide, *p*',*p*'-dioctyldiphenylamine (recrystallized) and 2-phenylbenzoselenazole. The selenium compounds showed slightly more oxidation retarding properties, but also attacked silver and copper more vigorously. In Table 1 the additives are listed in approximate decreasing order of effectiveness.

The main property change for evaluation purpose is that of per cent kinematic viscosity change. Values for this have been determined at three temperatures, 130°, 212° and 383°F, Table 1.

The viscosity increased linearly with oxidation time, both in the absence and presence of additives and the test metal washers. The changes in acidity were not of sufficient magnitude to be of value in the screening of additives. The "evaporation losses" expressed as per cent weight loss are erratic and do not reflect, except qualitatively, the effect of an additive in inhibiting or retarding the oxidation rate. The erratic behavior in part arises from bumping in the oxidation cells and splashing of liquid on the adapter and condenser walls. The intensity of bumping increases with time and appears to be associated with a more volatile product, produced either by oxidation or pyrolysis. It might be presumed to be water to a considerable extent. No attempt was made to analyse the mixture to be sure of this assumption.

The isooctane insolubles were determined in two ways. First, the oxidized mixture was filtered and the residue washed with isooctane. This residue is termed "isooctane wash", W', Table 1. The amount was usually small. The second value, P' in Table 1, is the per cent insoluble matter precipitated by addition of isooctane to the filtered oil. These values are somewhat erratic and do not help much in evaluating the effectiveness of an additive. The detailed procedure for separating and analysing the solid fractions is included later in the section on bis-(2-ethylhexyl) sebacate.

The effect of this mineral oil under oxidation with metals is not clearly shown because of the inherent difficulties in interpreting

the behavior of metals. In Table 1, two values are given for the weight losses in the test metal washers. Both are in milligrams per square centimeter. The first values are for the losses observed after cleaning the metal with benzene and acetone and soft tissue. The second values are the additional weight losses arising from more vigorous cleaning with fine glass wool and the solvents.

The oxidized fluid itself did not attack the metals severely, so the changes observed reflect the effect of the additives on the test metals. The sulfur containing additives, showing promising oxidation-retarding capacity with surprising low attack on silver and copper, were phenothioxine and diphenyl sulfide. For the selenium compounds 2-phenylbenzoselenazole scarcely attacked the metals, but it was less active in retarding oxidation than diphenyl selenide. The amines showing oxidation retarding activity generally did not strongly attack the metals. The most promising of the amines is recrystallized p,p'-dioctyl diphenylamine, followed by phenyl-alpha-naphthylamine and dipyridylamine.

The results with the spectrum of additives in this mineral oil indicate that several types may have promise as antioxidants and oxidation retarders. Some modification of the basic structures by substituents may be indicated to reduce volatility and increase the solubility. There is also some indication that mixtures of additives at the same total equivalent concentration will allow the use of lower amounts and promote more homogeneity in the system throughout its period of use.

C. Oxidations in a Methyl Chlorophenyl Silicone, F-60

This is the first report of experiences with this fluid. Oxidations were performed on two batches at 500° and 600°F. The first batch of 1 gallon in a metal container arrived 9 September 1956 from Material Laboratory, Wright Air Development Center. The results are noted in Table 2. The second batch of 1 quart in a glass bottle arrived 3 March 1957 and was labelled Dow-Corning F-60 Stock No. 7500-DL. The data for this batch are in Table 3.

The results with the two batches are essentially in agreement in the patterns of behavior toward additives and metals. The oxidations at 500°F were performed on 25 ml samples with dry air at 1 liter per hour. Most of the runs at 600°F were performed under the same conditions with a dry gas mixture consisting of 95% nitrogen and 5% oxygen.

The most attractive oxidation inhibitor and retarder was N,N'-di-2-naphthyl-p-phenylenediamine. A concentration of 0.2% prevented a significant increase in the kinematic viscosity for at least 48 hours at 500°F and 12 hours at 600°F. The changes in neutralization numbers were small and this measurement is not of great value in screening and comparing additives.

This fluid under oxidation attacked copper slightly more than the other test metals, but the metals appeared to have very little

effect in catalyzing the oxidations. The formation of insolubles was not dramatic. The slight effects are more clearly shown with the second batch; Table 3.

This additive is not as readily soluble as would be desired, but lower concentrations might be employed in practice if the available oxygen concentration is low. Some attention was given to the effect of additional purification of the commercial sample of N,N'-di-2-naphthyl-p-phenylenediamine. This substance was obtained as P5691, yellow label, Eastman Organic Chemicals. It was of grey-green color. A portion was placed in boiling ethanol and the mixture filtered. Only a small amount of N,N'-p-di-2-phenylenediamine dissolved in the alcohol, but this washing process helped to remove some impurities. A portion of the alcohol washed solid was dissolved in boiling acetone followed by filtration. Small granules of a almost white color precipitated on cooling. These were washed with cold ethanol and recrystallized from acetone. On drying by pulling air through the filter, the granules acquired a slight greenish tint. The results with the purified materials are reported in Table 2 and are designated by Footnote a/. The purification did not cause any significant change in the oxidation inhibiting behavior. Additives of ring substituted phenylenediamine types are also attractive, and may have better solubility characteristics. The results in Table 2 indicate that quinoid structure apparently possesses the oxidation inhibiting activity and that aryl substituents on the nitrogen are preferred.

In one instance vanadyl-2-ethyl hexoate was mixed with N,N'-di-2 naphthyl-p-phenylenediamine but the combination showed no special advantages. The former has some oxidation inhibiting qualities but the effects were not dramatic. Other additives exhibiting some promise as oxidation inhibitors at 500° and 600°F were diphenylguanidine, di-2-naphthylamine, acridine and 2,2'-dipyridylamine.

In some runs with mixtures of N,N'-di-2-naphthyl-p-phenylenediamine and acridine there appears to be some enhancement of the oxidation inhibiting property as well as an apparent decrease in an attack on copper. The limited supply of this fluid prevented further exploration of the effect of mixtures, particularly derivatives of morpholine. However, it is probably reasonable to assume that the same consideration will hold with this type as shown with the F-50 fluid, Table 5. Attention should be called to Run 329.10 in which 2-phenylbenzoselenazole and p-aminoethylmorpholine were used. It appears that the morpholine may have some inhibiting effect on the selenium compound.

To show more clearly, the behavior of insolubles in the methyl chlorophenyl silicone fluids, the data are tabulated separately; Tables 4 and 6. A part of the section on bis-(2-ethylhexyl) sebacate describes in detail the experimental procedure used for getting values for four types of insolubles. In brief, at 500°F, the oxidized fluid was filtered through a weighed porcelain crucible with asbestos mat. As much as possible of the liquid was drawn through the filter with suction. Then the crucible was weighed and the change in weight expressed as per cent oil insoluble. Next, the residue was washed with isooctane,

sucked dry and weighed. It appears with the methyl chlorophenyl silicone fluids that there was very little oil insoluble matter produced because, upon evaporation of the isooctane wash, the residue was mainly the starting fluid. Washing the filter mat with acetone generally did not show any significant change. Finally, the oil filtrate was treated with two 50 ml portions of isooctane and the precipitate separated by the centrifuge. The quantities precipitated could be a measure of some of the more polar substituents formed on oxidation. With N,N'-di-2-naphthyl-p-phenylenediamine the quantity of precipitate seemed to be roughly a function of the concentration of additive and the temperature. When the concentrations were in the neighborhood of 0.1%, the isooctane precipitate was usually small. When the expression "not filterable" was used in the tables the implication is that filtration was very slow and a useful quantity of filtrate could not be obtained in a reasonable time. At 600°F the insoluble effects are much more apparent. Here, comparison of a blank oxidation, Run 409.5, with a sample of fluid containing N,N'-di-2-naphthyl-p-phenylenediamine, Run 409.6, suggests that the additive may have some effect in reducing the insoluble matter.

A comparison of the results on the F-60 fluid with the data on the F-50 fluid indicates that the F-60 fluid possesses a greater inherent stability. The general appearance of the infra-red spectra on both oxidized and unoxidized samples of both fluids are essentially the same. This suggests that the difference may be due to a higher phenyl content in F-60. In future work with this type of fluid it is suggested that more attention be directed toward learning more about the oxidation and thermal degradation processes. It is not possible on the basis of data herein to separate the two processes clearily. In future work with additives at higher temperatures it is suggested that more attention be given to evaluating other aryl amines and phenylenediamines, both from the point of achieving better antioxidants and greater thermal stability of the additives.

D. Oxidations in a Methyl Chlorophenyl Silicone, F-50 Type.

This is the first report of experiences with a fluid labelled F-50. However, considerable experiences have been reported previously (Part VII) with the closely resembling fluid, MLO 53-446. About a one gallon sample of F-50 was received in a metal container through WADC channels on 18 March 1957. It was labelled Lot No. 124, Versilube F-50, Silicone Fluid from Silicone Products Department, General Electric Company. Tables 5 and 6 contain the detailed experimental data for this fluid. The quantities of additives listed in the table are expressed in grams per 25 ml of fluid. Multiplication of the gram weight by 4 gives an approximate value of the per cent of the additive.

N,N'-di-2-naphthyl-p-phenylenediamine appears to be the most generally available and useful additive for this fluid. However, the same solubility considerations hold as described for the F-60 fluid. Some related types of phenylenediamines, acridine, diphenylguanidine, 2,2'-dipyridylamine, p-aminodiphenyleneamine, and 2,4-bis-(phenyl mercapto) toluene, also showed inhibiting properties. Of some academic interest was Morgan's Base, which is a dibenzo acridine. This substance

is less volatile than acridine and appears to have considerable inhibiting activity.

Table 5 shows the effect of time of oxidation and concentration of N,N'-di-2-naphthyl-p-phenylenediamine at 500°F. There appears to be an induction period up to 48 hours. The concentration of additive is not critical in the range 0.1-0.2%. At 600°F this additive also has some effectiveness, but as with F-60, it is difficult to distinguish between thermal and oxidative effects. Mixtures of additives with N, N'-di-2-naphthyl-p-phenylenediamine may have lowered the attack on the metals, but they did not promote any outstanding or novel oxidation inhibiting properties. It is premature to eliminate mixtures from further consideration because better techniques are needed to determine the corrosion effects, particularly on silver and copper. In no instance, at 500°F, was the attack on the test metals of large order, except in the case of 2,4-bis-(phenyl mercapto) toluene. At 600°F there seems to be an increased effect of corrosion on stainless steel in all systems.

In several determinations of the kinematic viscosity change, two values were reported for 54.5° and 100°C. In determining the kinematic viscosity at these temperatures it has been customary to use a viscometer of the 300 series in order to have a reasonable time flow. In all determinations at 195°C a smaller bore viscometer of the 200 series was used. In those cases where there was considerable oxidation of this silicone fluid, the per cent viscosity change at 195°C was higher than might have been expected. In Table 5, for those cases where the kinematic viscosity were determined in a 200 series viscometer at the three temperatures, the values at 54.5° and 100°C are shown in parenthesis. It is suggested that some type of surface effect is responsible for the anomalies shown. The conclusion on oxidation inhibitors, however, are not seriously affected by this finding.

The overall behavior of the F-50 fluid appears to indicate this fluid has less stability than F-60. The difference is assumed to arise from small amounts of unknown impurities. Some attention has been given to chromatographic separation of both the oxidized and unoxidized fluids followed by obtaining the infra-red spectra of fractions with a Perkin-Elmer, Model 21B, Infra-red Recording Spectrophotometer. The range of this instrument is from 2-15 microns (5000 cm^{-1} to 650 cm^{-1} wave numbers). The chromatographic apparatus constructed is a modification of that described in WADC TR 54-464 Pt III, ASTIA Document No. AD 118215. Comparison of the spectra with that reported for known silicone compounds showed some expected bands. However, assignment of compositions to the chromatographically separated fractions is speculative. It should be mentioned that from unoxidized F-50 a small amount of solid was isolated after elution from alumina with an ethanol-water mixture. It does not seem to have a chloro group in it and loses considerable weight on strong heating to leave a white residue. The infra-red spectrum is not readily fit to known substances. Additional study is needed on this aspect.

E. Oxidations in a Methyl Chlorophenyl Silicone, 81406, (MLO 53-446)

The oxidative behavior of this fluid was studied in considerable detail during the previous contract and last year. Parts VI and VII of this series of technical reports contain the details of many oxidation runs, both alone and in the presence of additives and metals. This fluid appears to be very similar to the F-50 fluid and the general considerations discussed in the preceding section will apply. During the current year runs were performed with N,N'-di-2-naphthyl-p-phenylenediamine, which had been shown to be of promise, to determine the minimum equivalent quantity needed to produce maximum oxidation inhibiting effect with low attack on the test metals. The quantities of additives listed in the tables are expressed in terms of grams per 25 ml of fluid. The multiplication of the gram quantity by four gives an approximate value of the percentage of the additive. See Table 7.

At 500°F in the presence of aluminum, silver, copper, stainless steel and titantium, quantities of N,N'-di-2-naphthyl-p-phenylenediamine as low as 0.20% held the viscosity change within 30% for 48 hours in the presence of 95% N_2 and 5% O_2. With air under the same conditions the viscosity change was about 50% in 24 hours. With a concentration of about 1.0% N,N'-di-2-naphthyl-p-phenylenediamine the viscosity change was held within 10% for 48 hours in the presence of air. The response to concentration is not necessarily linear and there appears to be an optimum quantity for most efficient use. For possible operating conditions it is suggested that about 0.2% be tried.

A few other additives were examined at 500°F, but only N,N'-di-(2-methyl-3-chlorophenyl)-p-phenylenediamine appeared as good as N,N'-di-2-naphthyl-p-phenylenediamine. However, it was noted with this fluid that p-aminodiphenylamine has an interesting functional system and gave indication of considerable activity at low concentrations with very little effect on the test metals. Work with this silicone, MLO 53-446, was discontinued in favor of the more thermally stable F-60 type.

F. Oxidations in the Silanes.

Four tetra substituted silanes were examined during the current year. These were: didodecyl-dioctyl silane, MLO 57-161 and MLO 56-611; n-octadecyl-tri-n-octyl silane, MLO 56-578; and diphenyl-di-n-dodecyl silane, MLO 56-280. In the previous year some exploratory runs were made with the tetrakis-n-dodecyl silane, MLO 54-408D. The results were reported in Part VII of this report series. The new data are included in Tables 8, 9, 10 and 11.

The general pattern of oxidation of the silanes indicate considerable inherent resistance to oxidation in these types of fluids under the conditions of the evaluation. No additive showed outstanding antioxidant or oxidation retarding effects. The blank runs without additives were somewhat erratic. This presumably is due in part to excess bumping of this type of fluid during the oxidation run. The additives while not changing the general pattern significantly, did promote more consistency in the behavior. Selenium containing additives seem to be the most effective. However, the behavior could

not be related to concentration. Some heterocyclic amines also showed some inhibiting action. It appears that too large a quantity of additive might catalyze effects due to oxidation or thermal degradation. Of several selenium additives examined 2-phenylbenzoselenazole appeared to be the most versatile. This substance retards oxidation and attacked copper and silver least of the selenium compounds examined.

It is difficult to rate the silanes in order of stability. In an approximation the di-n-dodecyl-di-n-octyl silane, MLO 56-611, appears to be the best.

For future work with the silanes it is suggested that a larger variety of additives be screened, especially those which showed activity at high temperatures in mineral oils.

G. Oxidations in a Methyl Phenyl Silicone, MLO 9840.

During the previous year the behavior of this fluid was investigated in considerable detail. The results are reported in Part VII of this series of technical reports. Table 12 contains four runs using acridine to show the effects of purification of the commercial sample. The fraction crystallized from ethanol appeared to have considerable more inhibiting action than the solid fraction contained upon evaporation of the solvent.

H. Oxidations in a Pentaerythritol Ester, Hercules J-19, (MLO 55-584)

A series of oxidation runs were performed with this fluid at 400° and 500°F, in the presence and absence of metals and with selected additives, to determine which of several additives appear to be the best for future evaluations under more practical conditions. The results are in Table 13. The standard for comparison is the phenothiazine type. At 400°F this type was very effective, but it had little action at 500°F. One of its main drawbacks is the formation of oil insoluble matter as an end product. No convenient way has been found to eliminate this "dirtiness" factor.

The general pattern of behavior of this ester is the same as that of bis-(2-ethylhexyl) sebacate, which has been studied in much detail. During the current year new attention was given to several aryl-amine-type additives. Diphenylamine showed some effectiveness at 400°F with only a small amount of "dirtiness". However, at 500°F it showed no activity. This is in part due to volatility because di-2-naphthylamine did retain its activity at 500°F. The behavior of 2,2'-dipyridylamine continues to be interesting in the presence of copper. Under these conditions this amine showed promising antioxidant activity at both 400° and 500°F. A thesis problem with this substance gives some indication that a copper-coordination compound is related to the antioxidant activity. With an amino group in the para position, as in p-aminodiphenylamine, the temperature range of the oxidation inhibiting effect was increased and at 500°F this additive showed considerable promise. It did, however, form some oil insoluble matter, but to a somewhat lower extent than phenothiazine. Presumably, the p-amino system

is acting in the same manner as the phenylenediamines, because in an amino diphenyl (CCL No. 367) the activity is not retained at the higher temperature.

A number of commercial preparations of the "Age-Rite" type were examined. Several showed some effectiveness in retarding increases in kinematic viscosity at 500°F. Perhaps the most attractive was "Age-Rite H.P."

Several mixtures of additives were explored but none showed outstanding properties. For future work with the pentaerythritol ester type fluid it is suggested that more attention be given to pyridyl amines and to amines of low volatility, such as substituted aryl amines.

I. Oxidations in Bis-(2-ethylhexyl) Sebacate.

This fluid has been the standard of comparison for other fluids since the beginning of this program. Whenever new additives were acquired they were screened in this fluid first as a basis for comparison. A system of 1% phenothiazine is considered the blank. The concentration of additives used was the molar equivalent amounts to 0.25 gram of phenothiazine in 25 milliliters of diester. During the current year considerable attention was given to learning more about the behavior of insolubles and the accumulation of acids in fractions obtained by filtration and treatment with solvents. The results are in Tables 14, 15 and 16.

In the oxidation runs reported in Table 14, 10-methylphenothiazine is taken as a standard at 400°F. This substance has been shown to have slightly better performance than the parent compound, phenothiazine. At 500°F the phenothiazine type showed very little antioxidant activity. Diphenylamine in larger equivalent quantities was slightly active at 500°F, apparently because enough remained in the fluid to retard the oxidation. Ring substituted diphenylamines showed more activity at the higher temperatures. The most attractive appeared to be p-aminodiphenylamine. As previously reported, 2,2'-dipyridylamine continues to be attractive in the presence of copper.

An interesting aspect of N,N'-diphenyl-p-phenylenediamine is that recrystallization of the commercial sample from Eastman Kodak caused considerable increase in the antioxidant activity of the purified compound. Of several "Age-Rite" types examined, "Age-Rite H.P." appeared most promising. However, the differences among this series were small.

Some of the morpholines were interesting in that they seemed to have more activity at the higher temperatures. Two interesting new substances were cadmium diamyl dithiocarbamate and 4,4'-bisthiopicolinamido diphenyl. Both of these had some antioxidant activity but attacked copper and silver. A very low concentration of 4,4'-bisthiopicolinamido diphenyl in mixtures with phenothiazine and 2-phenylbenzoselenazole may have some slight activity in preventing attack on metals.

J. Acidity Effects in Oxidized Bis-(2-ethylhexyl) Sebacate.

A series of oxidation runs was performed in an attempt to show the behavior of acid accumulation in several fractions of the oxidized fluid, Table 15. The experimental procedure is outlined at the end of this section.

As expected the percentage of fluid insolubles increased as a function of the phenothiazine concentration. In the isooctane precipitate the oil itself seems to be the main contributor. However, the acid material in the oil insoluble fraction appears to arise more from the fluid rather than the additive. The removal of oil insoluble matter lowers the acidity of the oxidized fluid only slightly. Perhaps the best indication of extent of oil insoluble formation is the residue remaining after washing with isooctane. This treatment removes occluded oil and does not seem to dissolve an appreciable amount of the insolubles. The acidity of this solid residue comes mainly from the oxidized fluid, with only a small contribution from phenothiazine.

The precipitation of solids upon addition of a large excess of isooctane to the oxidized fluid, followed by centrifuging and weighing, has been previously reported as per cent isooctane insolubles. The values for the per cent of isooctane precipitate in Table 16, while not strictly comparable because these values are for the precipitate formed after removal of the oil insoluble matter, nevertheless do point to the relative contributions of the oxidized fluid and the expended additive. It appears that both are factors, but that the fluid makes the major contribution after a fraction of the expended additive has been removed by filtrations. The acidity of the isooctane precipitates arise to a considerable extent from the fluid and presumably is sebacic acid and some unknown substances.

The acidities of the oil after removal of the excess isooctane indicate that some improvement of the fluid results from the isooctane wash. No attempt was made to determine the optimum condition for washing an oxidized fluid. The indications are that this procedure may be of value in reclaiming a diester fluid provided the oxidation has not been excessive.

As a thesis problem this investigator expects to continue to study the behavior of a few additives in bis-(2-ethylhexyl) sebacate to learn more about their mechanism of behavior. Particular attention will be given to studying those systems of metals and amines in which the metals appeared to enhance the antioxidant activity. In some exploratory runs this effect seems to be more general than originally expected. From time to time the investigator will also examine other types of compounds with interesting structures in order to fill-in gaps in the total picture of antioxidant and oxidation retarders.

K. Procedure for Determination of Insoluble Matter

1. Oil Insoluble. A thin filter mat of asbestos (long fiber, acid-washed) is prepared on the bottom of a 25 ml Gooch crucible and dried to

constant weight in an oven at 100°-110°C. About 5 grams of a uniform sample of the oil is added to the crucible and suction from a water pump applied. After pulling as much oil as possible through the filter, the crucible and residue are weighed. The difference between the weight of the empty crucible and the weight of crucible and residue is the weight of oil insoluble matter.

The amount of filtrate from this step is determined by catching the fluid going through the mat in a 10 ml weighed test tube placed under the filter tube inside of a 250 ml suction flask. The crucible is held during filtration by a glass filter crucible holder with most of the top cut off so that only about 1 inch remains above the stem. This shortened holder does not retain a significant quantity of fluid. The difference between the weights of the test tube gives the amount of filtrate. In calculating the per cent oil insoluble, the weight of the fluid sample is the sum of the weight of filtrate plus the change in weight of the crucible.

2. Isooctane Wash. The residue in the crucible is washed with 50 ml of isooctane with gentle suction. After all the isooctane has been removed from the filter and residue, the crucible is again weighed. The per cent not removed by the isooctane wash is found by dividing the weight of the residue by the weight of the fluid sample.

3. Acetone Wash. The residue in the crucible is weighed after washing with 50 ml of acetone twice with gentle suction.

4. Isooctane Precipitate. The oil from the first filtration is put into a 50 ml centrifuge tube and 50 ml of isooctane added and thoroughly mixed. After standing for about 24 hours, the tube is centrifuged for 15 minutes, or until the centrifugate is packed tightly enough to allow supernatant liquid to be removed easily. Another 50 ml of isooctane is added to centrifugate and stirred. After centrifuging again and removing the supernatant liquid, the solid in the tube is heated until all isooctane has evaporated in an oven at 90-100°C. This isooctane precipitate is the difference in weight of the empty centrifuge tube and the weight of the tube plus solid. This is expressed as a per cent of the fluid sample.

The main error in the above procedure is in the value of oil insolubles due to the uncertainty of pulling all of the oil through the filter mat. The weighings are made to 10 mg for the filtrate, 0.1 mg for oil, isooctane and acetone residues, and to 1.0 mg for the isooctane precipitate.

5. Neutralization Numbers. The determination of the neutralization number of each of the residues and the fluids is of interest in the possible reclaiming of partially oxidized fluids. To show the behavior of the acidity of the solvents the filter crucible is placed in a beaker and treated with the usual mixtures of water, acetone and methanol, followed by titration with standard KOH as in a neutralization number determination. The isooctane supernatant was evaporated back to the oil and the acidity of a weighed portion of the oil determined.

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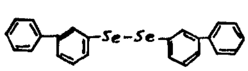
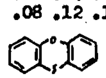
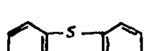
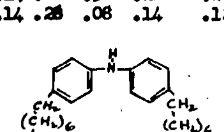
APPENDIX I. Tables of Oxidation Data.

TABLE 1

Oxidations in Mineral Oil, MLO 57-30

25 ml Sample Air Flow 1 l/Hr.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble,[1] W	P
None, No Metals	418.1	260° (500°)	12	1.2	17.0	11.7	4.1	1.3	0.032	0.50
None, No Metals	418.2	260° (500°)	24	1.4	35.0	11.7	12.5	1.3	.058	0.50
None, No Metals	418.3	260° (500°)	48	3.0	72.3	52.5	30.7	1.0	.081	0.68
None, Al Ag Cu S.S. Ti 0.04 .18 .26 .12 -.10 0.04 .04 .02 .02 .02	418.4	260 (500°)	12	0.8	11.9	8.1	0.0	1.3	.048	0.59
None, Al Ag Cu S.S. Ti 0.12 .18 .20 .18 .00 .04 .14 .14 .12 .18	425.1	260° (500°)	24	3.4	43.9	30.9	14.9	1.7	.010	0.63
None, Al Ag Cu S.S. Ti 0.18 .14 .22 .32 .06 .04 .04 .02 .04 .02	418.5	260° (500°)	24	1.4	41.5	29.1	11.3	1.2	.048	0.68
None, Al Ag Cu S.S. Ti 0.22 .22 .20 .40 .08 .06 .06 .10 .02 .04	418.6	260° (500°)	48	1.4	60.0	38.3	39.4	0.9	.134	6.9
None, Al Ag Cu S.S. Ti 0.00 .06 .08 .32 .04 .02 .04 .10 .04 .02	424.3	260° (500°)	48	6.7	82.4	56.3	36.0	1.0	.141	0.68
Phenyl selenide, No. 282PCB, 0.30g. Al Ag Cu S.S. Ti 0.02 -.14 1.78 1.10 .26 .18 .62 .46 .34 .24	426.3	260° (500°)	24	4.5	14.3	10.0	4.9	1.4	.000	1.16
282PCB 0.15g. Al Ag Cu S.S. Ti 0.18 .72 -.04 .86 -.36 .08 .18 .98 .18 .08	429.10	260° (500°)	24	3.3	33.3	23.3	13.8	0.6	.019	0.97
282PCB, 0.30g. Al Ag Cu S.S. Ti 0.10 .54 2.54 1.14 .04 .06 .04 .06 .06 .00 $(C_6H_5)_2Se$	424.6	260°	48	10.8	59.5	42.8	27.8	0.6	.110	0.54
2,2'-Dibiphenyl diselenide, No. 314, 0.25g. Al Ag Cu S.S. Ti -0.36 -2.06 5.6 .14 -.22 .20 .94 1.9 .40 .10	428.9	260° (500°)	24	2.7	18.7	12.2	6.4	1.6	.045	0.50
314 0.125g. Al Ag Cu S.S. Ti 2.44 19.6 -2.6 5.13 -8.68 .02 .24 1.2 .14 .00	429.3	260° (500°)	24	2.8	24.0	16.8	8.6	1.0	.014	1.01
										
Phenothiexine, No. 54, 0.25g. Al Ag Cu S.S. Ti -0.28 -.24 .04 -.14 -.22 .08 .12 .14 .06 .06	427.3	260° (500°)	24	5.0	20.2	13.3	8.3	2.3	.030	2.41
										
Phenylsulfide, No. 132, 0.23g. Al Ag Cu S.S. Ti -0.40 -.30 -.30 -.08 -.08 .08 .16 .10 .02 .04	427.7	260° (500°)	24	6.2	19.9	13.5	9.7	1.7	0.06	2.36
										
p,p'-Dioctyldiphenylamine, No. 22, (recryst.) 0.49g. Al Ag Cu S.S. Ti 0.14 .06 .36 .22 .20 .14 .28 .08 .14 .12	425.9	260° (500°)	24	1.7	21.5	15.3	6.6	1.7	.000	0.87
										

1/ The values under W are the per cent oil insoluble after the isooctane wash. The values under P are the per cent solid precipitated by oxidation of isooctane to the filtered fluid.

Table 1. Oxidations in Mineral Oil, MLO 57-30 (Cont'd)

25 ml. Sample Air Flow 1 1/Hr.

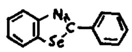
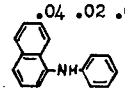
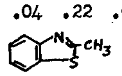
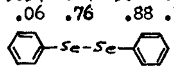
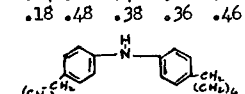
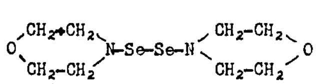
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W'	P'
2-Phenylbenzoselenazole, No. 300B, 0.32g. Al Ag Cu S.S. Ti 0.00 -.10 .22 .36 .24 .26 .34 .40 .28 .12	425.4	260° (500°)	24	4.3	22.3	14.7	7.1	7.1	-0.004	0.94
300B, 0.32g. No Metals	418.7	260° (500°)	48	3.0	77.3	53.0	27.3	4.5	.070	2.23
300B, 0.32g. Al Ag Cu S.S. Ti 0.10 .18 1.26 .14 .02 .10 .16 .10 .18 .10 	418.8	260° (500°)	48	3.4	96.0	55.3	43.2	4.5	.097	1.20
Benzyl disulfide, No. 321, 0.30g. Al Ag Cu S.S. Ti -0.22 -3.08 13.3 1.9 -.10 .08 3.02 1.1 .34 .06 $(C_6H_5CH_2S-)_2$	429.9	260° (500°)	24	2.6	22.1	16.3	9.3	1.4	.048	.62
Phenyl-alpha-naphthylamine, No. 61, 0.28g. Al Ag Cu S.S. Ti 0.06 .12 .06 .24 .08 .30 .34 .28 .30 .16	425.2	260° (500°)	24	2.5	25.3	18.0	8.6	0.9	.000	.79
61 0.28g. Al Ag Cu S.S. Ti 0.02 .16 .04 .18 .04 .04 .02 .06 .04 .00 	424.4	260° (500°)	48	5.7	61.5	45.8	30.1	0.5	.14	.58
2-Methyl benzothiazole, No. 213, 0.19g. Al Ag Cu S.S. Ti -0.16 -.02 .72 .20 -.10 .06 .04 .22 .00 .02 	429.8	260° (500°)	24	3.2	26.2	19.8	10.4	1.8	.047	.89
Diphenyl diselenide, No. 323, 0.20g. Al Ag Cu S.S. Ti 5.34 -7.84 13.6 -1.94 -1.94 .06 .76 .88 .16 .00 	429.4	260° (500°)	24	3.0	28.1	20.3	12.2	2.0	.060	.82
Dilauryl selenide, No. 271, 0.20g. Al Ag Cu S.S. Ti -0.18 2.74 3.30 .16 -.04 .00 .28 .10 .00 .06	429.1	260° (500°)	24	2.9	35.7	25.5	14.9	3.9	.091	.58
271, 0.40g. Al Ag Cu S.S. Ti -0.26 24.0 6.16 .18 -.28 .00 .74 .44 .00 .06 $[CH_3(CH_2)_{11}]_2$ Se	428.5	260° (500°)	24	3.6	29.0	20.6	11.3	3.4	.000	.51
2,2'-Dipyridylamine, No. 128, 0.24g. Al Ag Cu S.S. Ti 0.04 .00 .42 .12 .00 .18 .48 .38 .36 .46 	425.8	260 (500°)	24	3.7	31.0	22.4	13.2	1.9	.000	.99
Morpholine diselenide, No. 324, 0.10g. Al Ag Cu S.S. Ti -0.08 9.74 5.66 .30 -0.08 .10 2.56 .38 .06 .02	429.2	260° (500°)	24	2.6	37.8	26.0	15.5	1.2	.090	.88
324, 0.20g. Al Ag Cu S.S. Ti -0.02 14.3 10.4 .10 -.18 .22 1.5 .82 .26 .12 	428.4	260° (500°)	24	4.4	31.5	21.9	13.2	1.1	.22	.73

Table 1. Oxidations in Mineral Oil, MLO 57-30 (Cont'd)

Sample 25 ml, Air Flow 1 l/Hr.

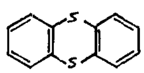
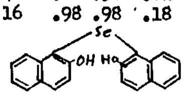
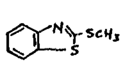
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W'	P'
Thianthrene, No. 6A, 0.05g. and Phenyl-alpha-naphthylamine, No. 61, 0.25g. Al Ag Cu S.S. Ti -0.08 -.22 -.14 -.20 -.34 .06 .10 .10 .02 .04 	427.2	260° (500°)	24	3.4	30.8	22.1	12.8	1.2	0.00	1.09
Thianthrene, No. 6A, 0.27g. Al Ag Cu S.S. Ti -0.20 -.20 .00 -.22 -.22 .08 .22 .12 .04 .04	427.1	260° (500°)	24	4.3	34.3	24.8	10.4	1.5	.03	.95
1-Cystine, No. 108, 0.30g. Al Ag Cu S.S. Ti -0.30 -.40 .68 .80 -.12 .12 .44 .60 .10 .04 $[HO_2CCHCH_2S—(NH_2)]_2$	427.4	260° (500°)	24	4.7	33.6	22.6	16.6	1.2	.13	1.14
4-Hydroxy-3,5-ditertiary butyl benzyl dimethylamine, No. 371, 0.32g. Al Ag Cu S.S. Ti -0.12 -.08 .20 .08 .14 .26 .32 .30 .24 .20	425.6	260° (500°)	24	3.1	40.4	29.1	15.8	1.3	.00	1.05
371,0.32g. Al Ag Cu S.S. Ti 0.04 .02 .08 .22 .26 .12 .06 .06 .02 .D2	424.9	260° (500°)	48	9.3	30.3	18.9	12.6	0.7	.07	.71
371 0.16g. and Na Sul (BSN) Barium Sulfonate Neutral Salt 50% Dispersion in Di-2-ethyl hexyl sebacate, 2 drops Al Ag Cu S.S. Ti 0.00 .06 .14 .20 .14 .12 .38 .30 .16 .24	425.10	260° (500°)	24	3.4	30.0	23.0	12.5	0.9	.00	.76
Di-(2-hydroxy-1-naphthyl) selenide, No. 307, 0.46g. Al Ag Cu S.S. Ti -0.40 28.6 8.30 -.02 -.20 .16 .98 .98 .18 .00 	428.8	260° (500°)	24	3.2	38.0	26.8	14.7	0.8	.45	.59
2-Methyl mercaptobenzothiazole, No. 208, 0.23g. Al Ag Cu S.S. Ti -0.08 -.26 1.36 1.58 -.02 .02 .12 .26 .14 .04 	429.7	260° (500°)	24	4.5	38.1	26.8	16.4	1.0	.06	1.36
Benzyl sulfide, No. 320, 0.27g. Al Ag Cu S.S. Ti -0.30 -1.32 .86 1.02 -.18 .02 .44 .66 1.24 .12 $(C_6H_5CH_2)_2S$	428.3	260° (500°)	24	5.2	38.4	27.0	18.9	0.9	.06	.97

Table 1. Oxidations in Mineral Oil, MLO 57-30 (Cont'd)

Sample 25 ml. Air Flow 1 1/Hr.

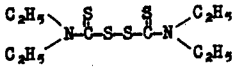
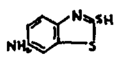
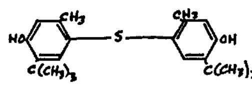
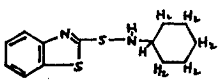
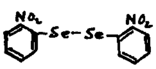
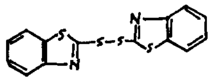
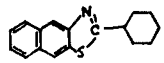
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W[1]	P[1]
Tetraethyl thiuram disulfide, No. 124, 0.37g., Al Ag Cu S.S. Ti -0.22 -.16 .10 .28 -.30 .14 .80 .54 .42 .20 	427.5	260° (500°)	24	4.3	39.0	30.3	16.3	1.5	0.02	1.54
6-Amino-2-mercaptobenzothiazole, No. 207, 0.23g. Al Ag Cu S.S. Ti -0.30 -1.60 .20 .74 -.42 .10 1.32 .74 .00 .18 	429.6	260° (500°)	24	2.4	39.6	31.0	19.7	0.8	.35	.77
4,4'-Thiobis 6-*tert*-butyl-*m*-cresol 0.44g. No. 156 Al Ag Cu S.S. Ti -0.14 -.30 1.34 0.24 -.30 .14 .24 .90 .12 .04 	427.9	260° (500°)	24	2.9	41.3	18.5	10.4	1.0	.07	4.93
N-Cyclohexyl-2-benzothiazole-sulfenamide, No. 163, 0.33g. Al Ag Cu S.S. Ti -0.18 -.18 5.54 .02 -.24 .16 .52 1.18 1.48 .08 	428.2	260° (500°)	24	4.4	41.4	31.3	20.0	0.4	.10	.61
o,*o*'-Dinitrodiphenyl diselenide, No. 303B, 0.25g. Al Ag Cu S.S. Ti -0.24 14.3 7.72 .14 -.44 .00 .76 .60 .04 .16 	428.7	260° (500°)	24	3.3	42.3	30.9	21.2	1.0	.25	.49
2,2'-Dithiobis (benzothiazole) No. 155, 0.41g. Al Ag Cu S.S. Ti -0.28 -.40 10.06 2.74 -0.24 .10 .52 .66 .78 .08 	427.8	260° (500°)	24	4.7	42.5	31.7	19.0	1.5	.00	2.36
2-Phenylnaptho(2,1)thiazole, No. 299, 0.32g., Al Ag Cu S.S. Ti -0.20 1.78 1.82 .30 -.08 .00 .44 .86 .30 .00 	428.6	260° (500°)	24	3.6	43.5	29.6	17.5	1.7	.06	.58
Phenyl disulfide, No. 322, 0.27g., Al Ag Cu S.S. Ti -0.46 -.30 1.86 .98 -.20 .22 .32 .42 .28 .12 $(C_6H_5-S-)_2$	428.10	260° (500°)	24	3.2	46.0	33.8	20.0	0.8	.08	.53

Table 1. Oxidations in Mineral Oil, MLO 57-30 (Cont'd)

Sample 25 ml. Air Flow 1 l/Hr.

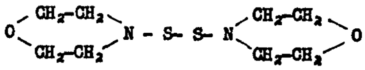
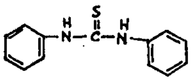
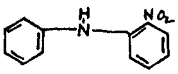
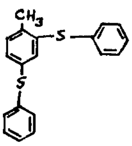
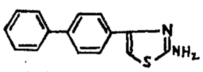
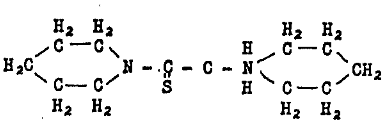
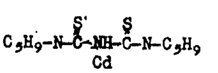
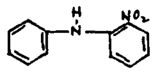
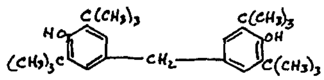
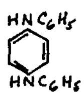
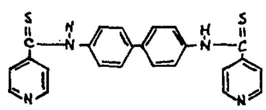
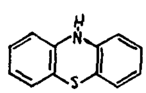
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %: 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W'	P'
4,4'-Dithiodimorpholine, No. 164, 0.30g. Al Ag Cu S.S. Ti -0.46 .10 1.60 .70 -.14 .10 .48 .44 .10 .02 	427.6	260° (500°)	24	4.1	49.8	36.0	21.9	1.3	0.02	1.58
N,N'-Diphenylthiourea, No. 159, 0.29g. Al Ag Cu S.S. Ti -0.30 -.38 2.74 .12 -.12 .06 .30 .30 .12 .02 	427.10	260° (500°)	24	4.1	52.0	15.2	23.9	1.2	.06	0.67
o-Nitrodiphenylamine, No. 87, 0.25g. No Metals	418.9	260° (500°)	48	2.9	78.7	60.1	36.7	0.8	.055	.43
87, 0.25g. Al Ag Cu S.S. Ti 0.22 .22 .52 .22 .04 .20 .26 .14 .10 .08 	418.10	260° (500°)	48	1.7	85.5	66.2	37.8	0.8	.131	1.38
2,4-bis (phenyl mercapto) toluene, No. 372, 0.36g. Al Ag Cu S.S. Ti 0.06 .16 .32 .70 .08 .06 .12 .12 .02 .06 	424.10	260° (500°)	48	5.2	81.0	58.8	37.2	1.0	.12	.55
2-Amino-4-(p-diphenyl)thiazole, No. 199, 0.31g. Al Ag Cu S.S. Ti -0.06 -16.74 4.96 -47.8 10.3 .04 .14 .50 .02 .06 	429.5	260° (500°)	24	2.3	66.7	49.5	29.9	1.6	.03	.70
Piperdinium-1-piperidine-carbodithioate, No. 160, 0.31g. Al Ag Cu S.S. Ti -0.06 -.04 -.18 .02 -.14 .14 .26 .84 .48 .00 	428.1	260° (500°)	24	3.1	70.5	52.6	35.7	1.5	.04	.58
Cadmium diamyl dithiocarbamate, No. 399, 0.50g. Al Ag Cu S.S. Ti 0.04 -0.08 1.28 .58 .02 .04 .34 .24 .06 .02 	424.8	260° (500°)	48	6.0	107.1	76.2	45.6	0.6	.09	1.02

Table 1. Oxidations in Mineral Oil, MLO 57-30 (Cont'd)

Sample 25 ml. Air Flow 1 l/Hr.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W'	P'
Acridine, No. 82, 0.25g. Al Ag Cu S.S. Ti 0.26 .56 .26 .58 .14 .02 .02 .00 .00 .02	424.2	260° (500°)	48	7.0	124.0	77.4	54.6	0.6	0.10	0.70
										
4,4'-Methylele bis-2,6-ditertiary butyl phenol, No. 370, 0.50g. Al Ag Cu S.S. Ti -0.04 .04 .04 .02 .04 .08 .04 .06 .04 .02	424.7	260° (500°)	48	7.4	190.5	119.0	66.3	0.6	.09	.62
										
N,N'-Diphenyl-p-phenylene-diamine, No. 186, 0.34g. (recrystallized) Al Ag Cu S.S. Ti 0.02 .02 .12 .10 .12 .14 .32 .20 .26 .20	425.5	260° (500°)	24	2.6	129.0	96.7	38.5	1.2	0.08	2.66
186 0.34g. Al Ag Cu S.S. Ti 0.12 .22 .18 .12 .06 .12 .20 .16 .02 .02	420.10	260° (500°)	48	6.3	N.M.	N.M.	N.M.	0.9	.11	.30
										
4,4'-bisthiopicolenamido diphenyl, No. 401 0.27g. Al Ag Cu S.S. Ti 0.04 .10 3.64 .34 -.02 .06 .06 .08 .02 .02	424.5	260° (500°)	48	9.6	211.0	144.5	74.5	0.6	0.50	1.12
										
Phenothiazine, No. 293, 0.25g. Al Ag Cu S.S. Ti -0.02 .00 -.86 -.10 -.12 .04 .04 .12 .02 .06	424.1	260° (500°)	48	6.7	N.M.	275.0	116.5	0.5	0.52	5.97
										

N.M. Too viscous for measurement.
N.F. Not Filterable.

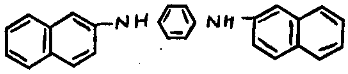
TABLE 2
Oxidations in Fluid F-60, First Batch

25 ml Sample

Additive, CCL No., Formula, Concentration, Metals Present		Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
None, No Metals	1/	358.1	260° (500°)	24	1.4	41	36	37	0.6	0.06
None, No Metals	1/	358.2	260° (500°)	48	2.9	153	134	115	0.4	0.02
None, Al,Ag,Cu,S.S.,Ti	1/	358.3	260° (500°)	24	1.5	25	22	17	0.7	0.04 a/
None, Al,Ag,Cu,S.S.,Ti	1/	358.4	260° (500°)	48	2.0	61	53	47	0.7	0.04 b/
None, Al,Ag,Cu,Cr-Mo,Ti	1/	358.5	260° (500°)	24	1.6	11	9	7	0.6	0.02 c/
None, Al,Ag,Cu,Cr-Mo,Ti	1/	358.6	260° (500°)	48	2.1	20	18	14	0.5	0.00 d/
None, No Metals	1/	366.1	316° (600°)	6	4.9	93	84	87	1.0	0.00
None, No Metals	1/	366.2	316° (600°)	12	2.4	665	575	670	1.4	0.16
None, No Metals	2/	351.1	316° (600°)	6	1.4	14	12	75	1.4	0.10
None, No Metals	2/	351.2	316° (600°)	12	2.5	48	43	140	1.7	0.02
None, No Metals	2/	350.1	316° (600°)	12	1.0	41	37	N.D.	1.5	0.08
None, No Metals	2/	350.2	316° (600°)	24	1.1	116	105	N.D.	1.3	0.04
None, Al,Ag,Cu,S.S.,Ti	2/	351.3	316° (600°)	6	1.7	19	17	84	1.7	0.04 e/
None, Al,Ag,Cu,S.S.,Ti	2/	353.1	316° (600°)	6	2.1	19	17	25	1.5	0.02 f/
None, Al,Ag,Cu,S.S.,Ti	2/	351.4	316° (600°)	12	3.4	50	46	87	1.8	0.08 g/
None, Al,Ag,Cu,S.S.,Ti	2/	353.3	316° (600°)	12	3.5	66	58	112	1.4	0.04 h/
None,Al,Ag,Cu,S.S.,Ti	2/	350.3	316° (600°)	12	2.5	53	48	N.D.	1.5	0.04 i/
None, Al,Ag,Cu,S.S.,Ti	2/	350.4	316° (600°)	24	4.3	202	183	N.D.	1.2	0.04 j/
None, Al,Ag,Cu,S.S.,Ti	3/	361.3		36	4.1	179	158	189	1.7	0.04 k/
None, Al,Ag,Cu,Cr-Mo,Ti	3/	361.4		36	7.5	86	73	79	1.7	0.10 l/
None, Al,Ag,Cu,S.S.,Ti	4/	364.1		48	3.3	270	244	208	1.1	0.06 m/
None, Al,Ag,Cu,Cr-Mo,Ti	4/	364.2		48	6.6	100	86	80	1.0	0.06 n/

1/ Gas Flow 1/hr. - Air
2/ Gas Flow 1/hr. - 95% N_2 - 5% O_2
3/ 24 hours with air at 260°C and 12 hours with 95% N_2 and 5% O_2 at 316°C.
4/ 24 hours at 260°C, raise to 316°C for 12 hours, after 36 hours drop to 260°C for 12 hours with 95% N_2 and 5% O_2. Total 48 hrs.
Metal Effects, Weight Loss, mg/cm²
a/ Al 0.06 Ag 0.52 Cu 0.90 S.S. 0.16 Ti 0.12
b/ Al 0.04 Ag 0.56 Cu 1.26 S.S. 0.00 Ti 0.06
c/ Al 0.20 Ag 0.46 Cu 0.86 Cr-Mo 0.28 Ti 0.26
d/ Al 0.02 Ag 0.36 Cu 0.84 Cr-Mo 0.02 Ti 0.02
e/ Al 0.14 Ag 0.46 Cu 0.46 S.S. 0.14 Ti 0.00
f/ Al 0.32 Ag 0.30 Cu 0.30 S.S. 0.20 Ti 0.02
g/ Al 0.28 Ag 1.02 Cu 1.00 S.S. 0.32 Ti-0.02
h/ Al 0.00 Ag 0.24 Cu 0.00 S.S. 0.22 Ti 0.00
i/ Al 0.10 Ag 0.90 Cu 0.38 S.S. 0.28 Ti 0.08
j/ Al 0.04 Ag 0.26 Cu 0.98 S.S. 1.5 Ti 0.02
k/ Al 0.20 Ag 0.64 Cu 1.08 S.S. 0.18 Ti-0.06
l/ Al 0.50 Ag 0.60 Cu 1.08 Cr-Mo 0.68 Ti 0.10
m/ Al 2.08 Ag 0.52 Cu 2.00 S.S. 0.92 Ti 0.20
n/ Al 0.32 Ag 0.80 Cu 2.40 Cr-Mo 1.00 Ti 0.18

Table 2. Oxidations in Fluid F-60 (Cont'd)
First Batch
25 ml Sample

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %. 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260 									
0.05 g. a/Al,Ag,Cu,S.S.,Ti 1/	357.3	260° (500°)	48	1.5	6	5	2.9	0.7	0.08 b/
0.05 g., Al,Ag,Cu,S.S.,Ti 1/	357.4	260° (500°)	48	2.1	6	4	3.4	0.6	0.06 c/
0.05 g., Al,Ag,Cu,Cr-Mo,Ti 1/	358.8	260° (500°)	48	1.3	4	3	1.3	0.5	0.12 d/
0.10 g. No Metals 1/	366.3	316° (600°)	6	1.7	9	7	5.7	0.7	0.38
0.10 g. No Metals 1/	366.4	316° (600°)	12	3.0	53	45	41	0.7	0.24
0.10 g. No Metals 1/	366.5	316° (600°)	24	1.3	4320	3550	N.M.	1.3	0.46
0.10 g., Al,Ag,Cu,S.S.,Ti 1/	366.6	316° (600°)	6	2.5	7	6	4.9	0.9	0.30 e/
0.10 g., Al,Ag,Cu,S.S.,Ti 1/	366.7	316° (600°)	12	3.6	62	54	52	1.0	0.38 f/
0.10 g., Al,Ag,Cu,S.S.,Ti 1/	366.8	316° (600°)	24	8.3	N.M.	N.M.	N.M.	0.7	92.1 g/
0.025g., Al,Ag,Cu,S.S.,Ti 2/	353.2	316° (600°)	6	1.9	5	3	2.8	0.7	0.10 h/
0.05g., Al,Ag,Cu,S.S.,Ti 2/	353.5	316° (600°)	6	1.7	4	2	0.8	0.9	0.22 i/
0.10g., Al,Ag,Cu,S.S.,Ti 2/	351.9	316° (600°)	6	1.9	5	3	0.8	0.8	0.08 j/
0.025g., Al,Ag,Cu,S.S.,Ti 2/	350.5	316° (600°)	12	3.8	31	27	N.D.	1.5	0.14 k/
0.025g., Al,Ag,Cu,S.S.,Ti 2/	353.4	316° (600°)	12	2.6	21	18	20	0.9	0.10 l/
0.05g., Al,Ag,Cu,S.S.,Ti 2/	353.6	316° (600°)	12	2.9	17	15	15	1.1	0.18 m/
0.10g., Al,Ag,Cu,S.S.,Ti 2/	351.10	316° (600°)	12	2.3	5	3	3.2	1.0	0.26 n/
0.025g., Al,Ag,Cu,S.S.,Ti 2/	350.6	316° (600°)	24	2.4	172	155	N.D.	1.3	0.10 o/
0.05g.,Al,Ag,Cu,S.S.,Ti 2/	353.7	316° (600°)	24	4.1	69	62	61	1.1	0.18 p/
0.10g., Al,Ag,Cu,S.S.,Ti 2/	353.8	316° (600°)	24	4.6	41	36	31	1.1	0.40 q/

a/ The sample of additive tested here was subjected to a purification process. See comment in body of report, Page 6.

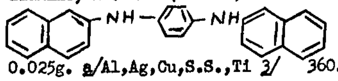
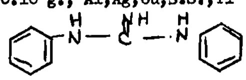
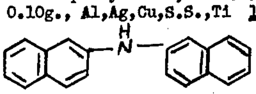
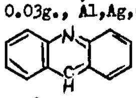
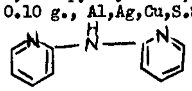
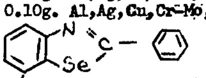
1/ Gas Flow 1/hr. - Air
2/ Gas Flow 1/hr. - 95% N_2 - 5% O_2.
Metal Effects, Weight Loss, mg/cm²
b/ Al 0.14 Ag 0.36 Cu 1.52 S.S. 0.04 Ti 0.10
c/ Al 0.08 Ag 0.40 Cu 1.76 S.S. 0.06 Ti 0.18
d/ Al 0.04 Ag 0.08 Cu 0.74 Cr-Mo 0.02 Ti -0.22
e/ Al 0.26 Ag 0.42 Cu 0.86 S.S. 0.34 Ti 0.32
f/ Al 0.60 Ag 0.76 Cu 1.10 S.S. 0.42 Ti 0.34
g/ Al 1.06 Ag 0.72 Cu 1.26 S.S. 0.70 Ti 0.36
h/ Al 0.04 Ag 0.28 Cu 0.44 S.S. 0.10 Ti 0.00
i/ Al 0.58 Ag 0.26 Cu 0.60 S.S. 0.02 Ti 0.00
j/ Al 0.08 Ag 0.22 Cu 0.58 S.S. 0.14 Ti 0.12
k/ Al 0.24 Ag 0.44 Cu 0.70 S.S. 0.42 Ti 0.04
l/ Al 0.06 Ag 0.54 Cu 0.56 S.S. 0.18 Ti 0.02
m/ Al 0.00 Ag 0.42 Cu 0.60 S.S. 0.20 Ti 0.00
n/ Al 0.18 Ag 0.40 Cu 0.82 S.S. 0.16 Ti 0.08
o/ Al 0.30 Ag 0.18 Cu 0.98 S.S. 0.70 Ti 0.06
p/ Al 0.02 Ag 0.66 Cu 0.56 S.S. 0.34 Ti 0.00
q/ Al 0.00 Ag 0.54 Cu 1.08 S.S. 0.14 Ti 0.00

N.M. Too viscous for measurement.
N.D. Not Determined.

Table 2 . Oxidations in Fluid F-60 (Cont'd)

First Batch

25 ml Sample

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
N,N'-Di-2-Naphthyl-p-phenylenediamine, No. 260 (Cont'd) 									
0.025g. a/Al,Ag,Cu,S.S.,Ti 3/	360.1		36	3.1	42	38	43	0.9	0.12 b/
0.050g. a/Al,Ag,Cu,S.S.,Ti 3/	360.2		36	3.4	40	35	45	0.9	0.18 c/
0.025g. a/Al,Ag,Cu,Cr-Mo,Ti 3/	360.3		36	2.7	42	37	45	0.9	0.02 d/
0.050g.,Al,Ag,Cu,Cr-Mo,Tia/ 3/	360.4		36	3.0	27	23	25	1.1	0.11 e/
0.05g., Al,Ag,Cu,S.S.,Ti 3/	361.1		36	4.0	41	36	37	1.5	0.06 f/
0.05g.,Al,Ag,Cu,Cr-Mo,Ti 3/	361.2		36	4.2	33	29	35	1.7	0.16 g/
0.05g.,Al,Ag,Cu,S.S.,Ti 4/	364.3		48	3.1	105	95	83	0.9	0.08 h/
0.05g., Al,Ag,Cu,Cr-Mo,Ti 4/	364.4		48	4.4	85	75	66	0.9	0.10 i/
0.1g., Al,Ag,Cu,S.S.,Ti 4/	364.5		48	3.0	108	96	83	0.9	0.10 j/
0.2g.,Al,Ag,Cu,S.S.,Ti 4/	364.6		48	3.3	80	72	63	1.1	0.02 k/
N,N'-Di-2-naphthyl-p-phenylenediamine, 0.050 g. and Vanadyl-2-ethyl hexoate, No. 379, 0.001 g., Al,Ag,Cu, S.S.,Ti 1/	358.7	260°C (500°F)	48	1.9	4	3	1.8	0.7	0.10 l/
Vanadyl-2-ethyl hexoate,No.379 0.050g.,Al,Ag,Cu,S.S.,Ti 1/	358.9	260°C (500°F)	48	2.3	43	38	31	1.0	0.44 m/
Diphenylguanidine, No. 161, 0.10 g., Al,Ag,Cu,S.S.,Ti 2/	351.7	316°C (600°F)	6	1.6	8	7	4.9	1.3	0.16 n/
	351.8	316°C (600°F)	12	3.0	27	23	22	1.1	0.24 o/
Di-2-naphthylamine, No. 383, 0.10g., Al,Ag,Cu,S.S.,Ti 1/	366.9	316°C (600°F)	12	3.1	29	24	21	0.9	0.16 p/
	366.10	316°C (600°F)	24	3.6	227	196	184	1.0	0.28 q/
Acridine, No. 82 0.03g., Al,Ag,Cu,S.S.,Ti 2/	350.7	316°C (600°F)	12	2.6	45	40	N.D.	1.3	0.04 r/
	350.8	316°C (600°F)	24	6.2	164	146	N.D.	1.2	0.06 s/
2,2'-Dipyridylamine, No. 128, 0.10 g., Al,Ag,Cu,S.S.,Ti 2/	351.5	316°C (600°F)	6	2.1	11	9	9	0.8	0.14 t/
	351.6	316°C (600°F)	12	3.4	33	29	28	1.5	0.24 u/
0.10g., Al,Ag,Cu,S.S.,Ti 1/	358.10	260°C (500°F)	48	2.3	35	30	25	0.4	0.04 v/
2-Phenylbenzoselenazole, No. 300B,									
0.10g. Al,Ag,Cu,S.S.,Ti 3/	361.5		36	6.3	154	134	127	1.9	0.10 w/
0.10g. Al,Ag,Cu,Cr-Mo,Ti 3/	361.6		36	8.5	152	133	133	2.1	0.12 x/
									

a/ The sample of additive tested here was subjected to a purification process. See comment in body of report, Page 6.

1/ Gas Flow 1/hr. - Air
2/ Gas Flow 1/hr. - 95% N_2 - 5% O_2
3/ 24 hours with air at 260°C and 12 hours with 95% N_2 and 5% O_2 at 316°C.
4/ 24 hours at 260°C and raise to 316°C for 12 hours, after 36 hours drop to 260°C for 12 hours with 95% N_2 and 5% O_2.

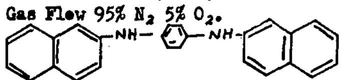
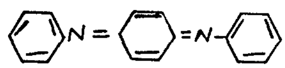
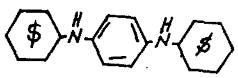
Metal Effects, Weight Loss, mg/cm²
b/ Al 0.08 Ag 0.26 Cu 1.26 S.S. 0.30 Ti 0.08
c/ Al 0.24 Ag 0.58 Cu 1.36 S.S. 0.54 Ti 0.22
d/ Al 0.28 Ag 2.56 Cu 1.16 Cr-Mo 0.76 Ti 0.18
e/ Al 0.28 Ag 0.68 Cu 0.98 Cr-Mo 0.58 Ti 0.18
f/ Al 0.18 Ag 0.80 Cu 1.06 S.S. 0.24 Ti 0.00
g/ Al 0.16 Ag 0.86 Cu 0.86 Cr-Mo 0.54 Ti 0.02
h/ Al 1.72 Ag 1.38 Cu 2.24 S.S. 1.16 Ti 0.42
i/ Al 0.70 Ag 1.92 Cu 2.00 Cr-Mo 1.42 Ti 0.38
j/ Al 0.90 Ag 0.88 Cu 1.94 S.S. 0.52 Ti 0.06
k/ Al 0.90 Ag 1.08 Cu 1.38 S.S. 0.44 Ti 0.16
l/ Al 0.12 Ag 0.26 Cu 0.58 S.S. 0.08 Ti 0.08
m/ Al 0.00 Ag 0.64 Cu 0.82 S.S.-0.08 Ti-0.16
n/ Al 0.42 Ag 0.94 Cu 1.00 S.S. 0.18 Ti 0.02
o/ Al 0.48 Ag 0.62 Cu 1.24 S.S. 0.30 Ti 0.00

Metal Effects, Weight Loss, mg/cm²
p/ Al 0.58 Ag 1.18 Cu 1.12 S.S. 0.38 Ti 0.38
q/ Al 0.98 Ag 1.48 Cu 1.42 S.S. 0.56 Ti 0.18
r/ Al 0.30 Ag 0.12 Cu 1.32 S.S. 1.02 Ti 0.04
s/ Al 0.24 Ag 0.06 Cu 1.88 S.S. 0.75 Ti 0.02
t/ Al 1.64 Ag 1.30 Cu 1.30 S.S. 0.58 Ti 0.06
u/ Al 1.04 Ag 1.24 Cu 1.26 S.S. 0.54 Ti 0.00
v/ Al-0.16 Ag 0.42 Cu 1.46 S.S. 0.10 Ti 0.02
w/ Al 0.50 Ag 0.76 Cu 0.56 S.S. 0.44 Ti 0.08
x/ Al 0.84 Ag 0.54 Cu 2.62 Cr-Mo 0.52 Ti 0.14

Table 3

Oxidations in Fluid F-60, Second Batch

25 ml sample

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
None, Al,Ag,Cu,S.S.,Ti 1/	392.1	260°C (500°F)	24	1.9	17.2	16.6	13.6	0.6	a/
None, Al,Ag,Cu,S.S.,Ti	392.2	260°C (500°F)	48	3.4	64.6	58.0	50.5	0.9	b/
None, Al,Ag,Cu,S.S.,Ti	397.6	260°C (500°F)	48	3.0	66.2	59.3	50.7	0.6	c/
None, Al,Ag,Cu,S.S.,Ti Gas Flow 95% N_2 5 % O_2.	409.4	316° (600°)	12	N.D.	47.0	42.6	37.8	0.6	d/
	411.10		12	N.D.	79.0	72.0	62.4	1.2	o/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010 g., Al,Ag,Cu,S.S.,Ti	398.5	260° (500°)	48	2.0	8.9	7.6	5.4	0.8	e/
0.025g.,Al,Ag,Cu,S.S.,Ti	397.10	260° (500°)	48	1.5	4.2	3.7	1.6	0.6	f/
0.025g.,Al,Ag,Cu,S.S.,Ti	398.4	260° (500°)	48	1.9	5.8	4.2	3.4	0.7	g/
0.05g., Al,Ag,Cu,S.S.,Ti	392.3	260° (500°)	48	2.0	5.2	4.9	3.6	0.8	h/
0.03g.,Al,Ag,Cu,S.S.,Ti Gas Flow 95% N_2 5% O_2.	409.2	316° (600°)	12	4.3	26.8	24.4	20.0	1.0	i/
									
N,N'-Diphenyl-1,4-benzoquinonediimine, No. 352 0.10g.,Al,Ag,Cu,S.S.,Ti	398.10	260° (500°)	48	2.7	8.0	6.4	5.7	1.0	j/
									
N,N'-Dicyclohexyl-p-phenylenediamine, No. 351 0.10g.,Al,Ag,Cu,S.S.,Ti	398.9	260° (500°)	48	3.5	14.4	12.3	10.2	0.9	k/
									
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260. 0.010g. and Diphenylguanidine, No. 161, 0.010g. Al,Ag,Cu,S.S.,Ti	398.7	260° (500°)	48	2.2	15.4	13.7	10.2	0.9	l/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g. and acridine, No.82, 0.050g., Al,Ag,Cu,S.S.,Ti	398.6	260° (500°)	48	1.5	3.3	2.6	2.6	0.7	m/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.005g, acridine, No. 82, 0.010g. and Diphenylguanidine, No. 161,0.005g. Al,Ag,Cu,S.S.,Ti	398.8	260° (500°)	48	1.3	4.4	4.3	3.2	0.6	n/

Metal Effect, Weight Loss, mg/cm²

a/ Al 0.14 Ag 0.36 Cu 0.82 S.S. 0.00 Ti 0.00
b/ Al 0.06 Ag 0.78 Cu 1.44 S.S. 0.00 Ti-0.04
c/ Al 0.08 Ag 0.10 Cu 0.94 S.S. 0.06 Ti 0.04
d/ Al 0.02 Ag 0.02 Cu 0.14 S.S. 0.04 Ti 0.02
e/ Al 0.02 Ag 0.10 Cu 0.20 S.S. 0.00 Ti 0.02
f/ Al 0.04 Ag 0.04 Cu 0.44 S.S. 0.04 Ti 0.06
g/ Al 0.02 Ag 0.02 Cu 0.10 S.S. 0.04 Ti 0.00
h/ Al 0.06 Ag 0.20 Cu 0.66 S.S.-0.04 Ti 0.00
i/ Al 0.02 Ag 0.00 Cu 0.36 S.S. 0.12 Ti 0.00
j/ Al 0.02 Ag 0.12 Cu 0.26 S.S. 0.04 Ti 0.00
k/ Al 0.04 Ag 0.16 Cu 0.44 S.S. 0.04 Ti 0.06
l/ Al 0.02 Ag 0.16 Cu 0.70 S.S. 0.02 Ti 0.02
m/ Al 0.12 Ag 0.08 Cu 0.18 S.S. 0.02 Ti 0.00
n/ Al 0.02 Ag 0.18 Cu 0.48 S.S. 0.00 Ti 0.04
o/ Al-0.70 Ag-0.28 Cu 0.22 S.S. 0.20 Ti-0.16

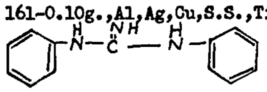
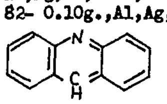
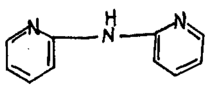
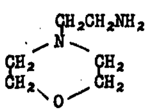
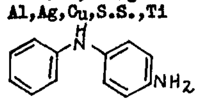
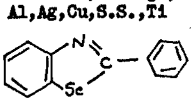
N.D. Not yet determined.

1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.

2/ These values are tabulated in a separate table.

Table 3 . Oxidations in Fluid F-60 (Cont'd).
Second Batch

25 ml Sample

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
Diphenylguanidine, 0.05g. 1/ No. 161, Al,Ag,Cu,S.S.,Ti	397.8	260° (500°)	3		3.9	3.1	8.6		
			48	1.1	12.1	10.7		0.8	a/
161-0.05g.,Al,Ag,Cu,S.S.,Ti	397.9	260° (500°)	24	1.7	5.4	4.7	3.8	0.8	b/
161-0.10g.,Al,Ag,Cu,S.S.,Ti 	392.8	260° (500°)	48	6.3	9.6	9.1	6.8	0.6	c/
Acridine, No. 82, 0.10g., Al,Ag,Cu,S.S.,Ti	397.7	260° (500°)	6		1.7	1.2			d/
			48	1.7	6.2	5.6	4.5	0.6	
82- 0.10g.,Al,Ag,Cu,S.S.,Ti 	392.7	260° (500°)	48	1.3	6.9	6.4	4.1	0.7	e/
2,2'-Dipyridylamine, No. 128, 0.10g., Al,Ag,Cu,S.S.,Ti 	392.6	260° (500°)	48	2.5	33.5	30.8	25.7	0.7	f/
N-Aminoethylmorpholine, No. 117,0.10g., Al,Ag,Cu,S.S.,Ti 	392.5	260° (500°)	48	3.6	32.2	27.8	22.8	0.8	g/
p-Aminodiphenylamine, No. 360,0.05g. Al,Ag,Cu,S.S.,Ti 	392.4	260° (500°)	48	2.2	23.7	20.5	17.5	0.8	h/
2-Phenylbenzoselenazole, No. 300B, 0.10g., Al,Ag,Cu,S.S.,Ti 	392.9	260° (500°)	48	5.2	43.2	38.1	31.8	0.7	i/
2-Phenylbenzoselenazole, No. 300B, 0.10g. and N-aminoethylmorpholine, No. 117, 0.05g. Al,Ag,Cu,S.S.,Ti	392.10	260° (500°)	48	3.5	51.2	45.7	39.7	0.8	j/

Metal Effects, Weight Loss, mg/cm²
a/ Al 0.08 Ag 0.16 Cu 0.94 S.S. 0.02 Ti 0.00
b/ Al 0.16 Ag 0.12 Cu 0.36 S.S. 0.04 Ti 0.02
c/ Al 0.00 Ag 0.16 Cu 0.84 S.S. 0.0[illegible] Ti-0.18
d/ Al 0.10 Ag 0.08 Cu 0.50 S.S. 0.02 Ti 0.10
e/ Al 0.00 Ag 0.56 Cu 0.66 S.S. 0.00 Ti 0.00
f/ Al 0.02 Ag 0.44 Cu 1.42 S.S.-0.26 Ti-0.28
g/ Al 0.02 Ag 0.40 Cu 0.98 S.S. 0.00 Ti-0.14
h/ Al 0.04 Ag 0.32 Cu 0.92 S.S.-0.14 Ti 0.00
i/ Al 0.00 Ag 0.84 Cu 2.26 S.S.-0.12 Ti 0.00
j/ Al 0.04 Ag 0.76 Cu 1.44 S.S.-0.08 Ti-0.06

1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/h5.
2/ These values are tabulated in a separate table, Table 4.

TABLE 4

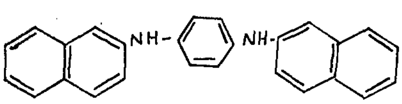
Behavior of Insolubles in Oxidized F-60 Blend

Additive, CCL No. and Concentration; Metals Present	Run No.	Time Hours	Temperature °C (°F)	Percentage Insoluble			
				Oil	Isooctane wash	Acetone wash	Isooctane Precipitate
None, Al,Ag,Cu,S.S.,Ti	392.1	24	260° (500°)	1.40	0.01	0.00	0.55
None, Al,Ag,Cu,S.S.,Ti	392.2	48	260° (500°)	0.72	0.01	0.00	0.59
None, Al,Ag,Cu,S.S.,Ti	397.6	48	260° (500°)	0.72	0.00	0.00	0.10
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Al,Ag,Su,S.S.,Ti	398.5	48	260° (500°)	0.91	0.01	0.00	0.11
260 0.025g., Al,Ag,Cu,S.S,Ti	397.10	48	260° (500°)	1.20	0.07	0.05	0.13
260 0.025g., Al,Ag,Cu,S.S.,Ti	398.4	48	260° (500°)	1.12	0.07	0.06	0.08
260 0.05g., Al,Ag,Cu,S.S.,Ti	392.3	48	260° (500°)	0.86	0.10	0.10	0.47
260 0.03g., Al,Ag,Cu,S.S.,Ti	409.2	12	316° (600°)	Not Filterable			
N,N'-Diphenyl-1,4-benzoquinonediamine, No. 352, 0.10 g., Al,Ag,Cu,S.S.,Ti	398.10	48	260° (500o)	1.13	0.01	0.00	0.19
N,N'-Dicyclohexyl-p-phenylenediamine, No. 351, 0.10 g., Al,Ag,Cu,S.S.,Ti	398.9	48	260° (500°)	1.88	0.18	0.16	0.21
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., and Diphenylguanidine, No. 161, 0.010g., Al,Ag,Cu,S.S.,Ti	398.7	48	260° (500°)	1.88	0.02	0.01	0.13
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g. and Acridine, No. 82, 0.050 g., Al,Ag,Su,S.S.,Ti	398.6	48	260° (500°)	1.08	0.01	0.00	0.11
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.005g., Acridine, No. 82, 0.010g. and Diphenyl guanidine, No. 161. 0.005g., Al,Ag,Cu,S.S.,Ti	398.8	48	260° (500°)	0.64	0.02	0.01	0.12
Diphenylguanidine, No. 161, 0.05g. Al,Ag,Cu,S.S., Ti	397.8	48	260° (500°)	0.89	0.00	0.00	0.13
161 0.05g., Al,Ag,Cu,S.S.,Ti	397.9	24	260° (500°)	0.91	0.02	0.01	0.36
161 0.10g., Al,Ag,Cu,S.S.,Ti	392.8	48	260° (500°)	0.98	0.02	0.02	0.59
Acridine, No. 82, 0.10g. Al,Ag,Cu,S.S.,Ti	397.7	48	260° (500°)	0.68	0.00	0.00	0.08
82 0.10g., Al,Ag,Cu,S.S.,Ti	392.7	48	260° (500°)	1.82	0.01	0.00	0.70
2,2'-Dipyridylamine, No. 128, 0.10g., Al,Ag,Cu,S.S.,Ti	392.6	48	260° (500°)	0.78	0.01	0.00	0.42
N-Aminoethylmorpholine, No. 117, 0.10g., Al,Ag,Cu,S.S.,Ti	392.5	48	260° (500°)	1.27	0.02	0.00	1.67
p-Aminodiphenylamine, No. 360, 0.05g., Al,Ag,Cu,S.S.,Ti	392.4	48	260° (500°)	0.82	0.03	0.02	0.52
2-Phenylbenzoselenazole, No. 300B, 0.10g., Al,Ag,Cu,S.S.,Ti	392.9	48	260° (500°)	0.75	0.00	0.00	0.51
2-Phenylbenzoselenazole, No. 300B, 0.10g. and N-aminoethylmorpholine, No. 117, 0.05g., Al,Ag,Cu,S.S.,Ti	392.10	48	260° (500°)	1.54	0.04	0.03	0.08

Table 5
Oxidations in Fluid F-50

Sample 25 ml.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
None, Al,Ag,Cu,S.S.,Ti 1/	396.1	260° (500°)	24	3.1	439.0	415.0	572.0	0.9	a/
None, Al,Ag,Cu,S.S.,Ti	397.1	260° (500°)	24	5.3	N.M.			N.M.	b/
None, Al,Ag,Cu,S.S.,Ti	396.2	260°C (500°)	48	10.4	N.M.			N.M.	c/
None, Al,Ag,Cu,S.S.,Ti Gas Flow 95% N_2 5% O_2	409.5	316° (600°)	12	6.3	209.0	196.0	193.0	0.9	d/
<u>N,N'-Di-2-naphthyl-p-phenylene-diamine,</u> 0.010g. No. 260, Al,Ag,Cu,S.S.,Ti	404.1	260° (500°)	48	3.3	170.9 (210.0)3/	157.0 (172.0)	147.0	0.9	e/
260 0.020g., Al,Ag,Cu,S.S.,Ti	404.2	260° (500°)	48	2.6	22.3 (41.3)3/	20.7 (24.3)	19.8	0.8	f/
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.3	260° (500°)	3	1.7	1.4	1.1			
			48	1.5	8.6	7.7	8.2	0.5	g/
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.4	260° (500°)	6	1.1	2.3	1.3			
			48	2.5	8.4	7.7	7.8	0.6	h/
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.5	260° (500°)	12	2.0	2.7	2.7			
			48	5.4	10.4	9.7	11.8	0.4	i/
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.6	260° (500°)	24	1.7	4.4	3.9	4.3	0.4	j/
260 0.025g.,Al,Ag,Cu,S.S.,Ti	397.5	260° (500°)	48	3.0	9.9	9.1	8.3	0.6	k/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.1	260° (500°)	6	1.7	2.2	2.0	1.7	0.4	l/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.2	260° (500°)	12	1.3	3.0	3.3	2.3	0.5	m/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.3	260° (500°)	18	1.9	4.6	3.9	3.1	0.5	n/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.4	260° (500°)	24	1.9	5.5	4.8	3.5	0.6	o/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.5	260° (500°)	30	2.4	7.4	6.6	6.1	0.5	p/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.6	260° (500°)	36	2.7	9.1	8.4	8.0	0.5	q/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.7	260° (500°)	42	3.3	11.4	10.5	10.5	0.6	r/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.8	260° (500°)	48	2.5	38.0	34.2	34.2	0.8	s/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	404.3	260° (500°)	48	2.2	12.0 (28.8)3/	10.5 (11.2)	10.6	0.7	t/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.9	260° (500°)	54	4.3	88.7	80.5	81.3	0.6	u/
260 0.030g.,Al,Ag,Cu,S.S.,Ti	402.10	260° (500°)	60	3.6	89.3	82.0	80.5	0.6	v/
260 0.030g.,Al,Ag,Cu,S.S.,Ti Gas Flow 95% N_2 5% O_2	409.6	316° (600°)	12	4.7	90.5	89.0	88.5	0.9	w/
260 0.040g.,Al,Ag,Cu,S.S.,Ti	404.4	260° (500°)	48	1.5	8.7 (22.6) 3/	7.8 (7.1)	7.2	0.7	x/
260 0.050g.,Al,Ag,Cu,S.S.,Ti	400.1	260° (500°)	48	3.2	11.8	10.9	10.0	0.6	y/



Metal Effects, Weight Loss, mg/cm²

a/Al 0.50 Ag 1.04 Cu 1.78 S.S. 0.04 Ti 0.02
b/Al 0.10 Ag 0.08 Cu 1.16 S.S. 0.08 Ti 0.00
c/Al 0.28 Ag 1.02 Cu 2.08 S.S. 0.06 Ti 0.00
d/Al 0.02 Ag 0.02 Cu 0.18 S.S. 0.32 Ti 0.00
e/Al 0.06 Ag 0.08 Cu 0.46 S.S. 0.04 Ti 0.16
f/Al 0.00 Ag 0.00 Cu 0.42 S.S. 0.04 Ti 0.12
g/Al 0.20 Ag 0.56 Cu 1.12 S.S. 0.14 Ti 0.10
h/ Al 0.06 Ag 0.42 Cu 1.02 S.S. 0.08 Ti 0.06
i/Al 0.08 Ag 0.22 Cu 0.80 S.S. 0.02 Ti 0.00
j/Al 0.06 Ag 0.42 Cu 0.76 S.S. 0.00 Ti 0.00
k/Al 0.12 Ag 0.04 Cu 0.74 S.S. 0.06 Ti 0.06
l/Al 0.00 Ag 0.02 Cu 0.14 S.S. 0.02 Ti 0.00
m/Al 0.06 Ag 0.08 Cu 0.44 S.S. 0.08 Ti 0.02
n/Al 0.06 Ag 0.14 Cu 0.56 S.S. 0.04 Ti 0.02
o/Al 0.02 Ag 0.08 Cu 0.74 S.S. 0.10 Ti 0.06

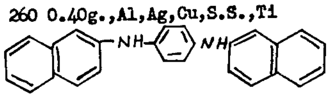
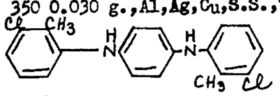
Metal Effects, Weight Loss, mg/cm²

p/Al 0.00 Ag 0.20 Cu 0.74 S.S. 0.06 Ti 0.04
q/Al 0.02 Ag 0.10 Cu 0.76 S.S. 0.08 Ti 0.12
r/Al 0.02 Ag 0.10 Cu 0.72 S.S. 0.04 Ti 0.00
s/Al 0.02 Ag 0.24 Cu 0.60 S.S. 0.02 Ti 0.04
t/Al 0.14 Ag 0.00 Cu 0.50 S.S. 0.00 Ti 0.10
u/Al 0.02 Ag 0.20 Cu 0.58 S.S. 0.06 Ti 0.02
v/Al 0.02 Ag 0.20 Cu 0.42 S.S. 0.06 Ti 0.02
w/Al 0.14 Ag 0.10 Cu 0.34 S.S. 0.34 Ti 0.04
x/Al 0.02 Ag 0.06 Cu 0.58 S.S. 0.02 Ti 0.06
y/Al 0.16 Ag 0.00 Cu 0.54 S.S. 0.12 Ti 0.00

N.M. Too viscous for measurement.
1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
2/ These values are tabulated in a separate table.
3/ See second paragraph of Page 8 for explanation of parenthesis.

Table 5 . Oxidations in Fluid F-50 (Cont'd)

Sample 25 ml.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %. 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260 (cont'd)									
260 0.050g., Al,Ag,Cu,S.S.,Ti	404.5	260° (500°)	48	2.9	10.4 (26,7) 3/	9.7 (9.9)	9.7	0.7	a/
260 0.050g.,Al,Ag,Cu,S.S.,Ti	406.1	260° (500°)	48	2.1	7.7	7.5	7.1	0.4	b/
260 0.075g.,Al,Ag,Cu,S.S.,Ti	404.6	260° (500°)	48	2.6	8.8 (26.5) 3/	8.0 (7.5)	8.2	0.5	c/
260 0.10g.,Al,Ag,Cu,S.S.,Ti	404.7	260° (500°)	48	1.7	7.8 (24.0) 3/	7.6 (7.7)	6.7	0.7	d/
260 0.15g.,Al,Ag,Cu,S.S.,Ti	404.8	260° (500°)	48	2.0	10.2 (26.4) 3/	9.4 (9.4)	9.4	0.6	e/
260 0.20g.,Al,Ag,Cu,S.S.,Ti	400.5	260° (500°)	48	3.7	13.6	13.0	10.0	0.6	f/
260 0.20g.,Al,Ag,Cu,S.S.,Ti	406.2	260° (500°)	48	3.6	10.4	10.3	8.4	0.4	g/
260 0.40g.,Al,Ag,Cu,S.S.,Ti	406.3	260° (500°)	48	3.6	11.3	10.3	9.8	0.3	h/
									
N,N'-Di-(2-methyl-3-chlorophenyl)-p-phenylenediamine, No. 350, 0.010g. Al,Ag,Cu,S.S.,Ti	398.2	260° (500°)	48	5.0	N.M.			0.8	i/
350 0.030 g.,Al,Ag,Cu,S.S.,Ti	398.1	260° (500°)	48	4.7	181.0	167.0	164.0	0.8	j/
									
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.025g., and Acridine, No. 82, 0.025g. Al,Ag,Cu,S.S.,Ti	400.7	260° (500°)	48	4.4	23.5	21.8	20.5	0.8	k/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.050g. and Phenylmorpholine, No. 141, 0.005g. Al,Ag,Cu,S.S.,Ti	400.9	260° (500°)	48	4.1	15.9	13.9	13.3	0.8	l/
260 0.010g., 141 0.010g. Al.Ag,Cu,S.S.,Ti	404.10	260° (500°)	48	3.5	130.0 (166.0) 3/	120.0 (134.0)	111.0	0.7	m/
260 0.050g., N-Amineethylmorpholine, No. 117, 0.005g. Al,Ag,Cu,S.S.,Ti	400.10	260° (500°)	48	4.0	34.4	38.3	36.8	0.8	n/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Acridine, No. 82, 0.010g. and Diphenylguanidine, No. 161, 0.010g. Al,Ag,Cu,S.S.,Ti	400.8	260° (500°)	48	23.9	N.M.			N.M.	o/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Acridine, No. 82, 0.010g., N-Phenylmorpholine, No. 141, 0.010g., Al,Ag, Cu,S.S.,Ti	404.9	260° (500°)	48	3.7	70.0 (93.5) 3/	64.0 (63.5)	59.8	0.9	p/

Metal Effects, Weight Loss, mg/cm^2

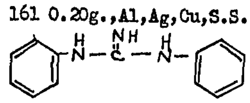
a/ Al 0.02 Ag 0.04 Cu 0.44 S.S. 0.00 Ti 0.00
b/ Al 0.42 Ag 0.48 Cu 1.08 S.S. 0.16 Ti 0.04
c/ Al 0.00 Ag 0.02 Cu 0.82 S.S. 0.00 Ti 0.00
d/ Al 0.02 Ag 0.02 Cu 0.90 S.S. 0.02 Ti 0.02
e/ Al 0.02 Ag 0.02 Cu 0.72 S.S. 0.00 Ti 0.00
f/ Al-0.30 Ag-0.32 Cu 0.38 S.S.-0.18 Ti-0.34
g/ Al 0.32 Ag 0.38 Cu 1.28 S.S. 0.24 Ti 0.10
h/ Al 0.28 Ag 0.34 Cu 1.18 S.S. 0.34 Ti 0.04
i/ Al 0.04 Ag 0.50 Cu 0.90 S.S. 0.02 Ti 0.02
j/ Al 0.06 Ag 0.02 Cu 1.26 S.S. 0.00 Ti 0.02
k/ Al 0.02 Ag 0.10 Cu 0.00 S.S. 0.00 Ti-0.28
l/ Al 0.06 Ag 0.02 Cu 0.30 S.S. 0.00 Ti 0.00
m/ Al 0.02 Ag 0.10 Cu 0.46 S.S. 0.02 Ti 0.02
n/ Al-0.24 Ag 0.02 Cu 0.78 S.S.-0.12 Ti 0.00
o/ Al-0.24 Ag 0.56 Cu 1.88 S.S. 0.02 Ti-0.26
p/ Al 0.02 Ag 0.14 Cu 0.70 S.S. 0.02 Ti 0.02

N.M. Too viscous for measurement.
1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
2/ These values are tabulated in a separate table.
3/ See second paragraph of Page 8 for explanation of parenthesis.

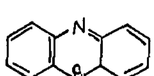
Table 5. Oxidations in Fluid F-50 (Cent'd)

Sample 25 ml

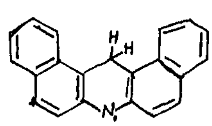
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
Diphenylguanidine, No. 161 0.05g., Al,Ag,Cu,S.S.,Ti 1/	396.13	260° (500°)	3	2.6	6.4	6.5			
			48	5.7	50.7	47.4	45.0	0.8	a/
161 0.05g.,Al,Ag,Cu,S.S.,Ti	397.3	260° (500°)	3	1.5	6.6	7.3			
			48	3.5	232.0	217.0	246.0	0.9	b/
161 0.10g.,Al,Ag,Cu,S.S.,Ti	396.14	260° (500°)	3	1.7	7.9	8.2			
			48	2.6	19.2	18.3	19.3	0.6	c/
161 0.05g.,Al,Ag,Cu,S.S.,Ti	396.11	260° (500°)	24	2.2	15.4	15.0	15.0	0.7	d/
161 0.05g.,Al,Ag,Cu,S.S.,Ti	397.4	260° (500°)	24	2.8	16.4	15.7	15.9	0.6	e/
161 0.10g.,Al,Ag,Cu,S.S.,Ti	396.12	260° (500°)	24	2.9	15.7	14.0	14.3	0.2	f/
161 0.20g.,Al,Ag,Cu,S.S.,Ti	400.6	260° (500°)	48	4.2	26.0	25.6	25.6	0.5	g/



Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
Acridine, No. 82, 0.05g., Al,Ag,Cu,S.S.,Ti	400.2	260° (500°)	48	4.0	26.6	25.1	23.4	4.0	h/
82 0.05g.,Al,Ag,Cu,S.S.,Ti	406.4	260° (500°)	48	3.2	19.4	17.8	16.7	0.8	i/
82 0.05g.,Al,Ag,Cu,S.S.,Ti Gas Flow - 95% N_2 5% O_2	409.10	316° (600°)	12	6.3	172.5	164.5	166.0	1.1	j/
82 0.075g., Al,Ag,Cu,S.S.,Ti	406.5	260° (500°)	48	3.4	19.3	18.4	17.5	0.6	k/
82 0.10g.,Al,Ag,Cu,S.S.,Ti	396.7	260° (500°)	3	2.0	2.1	2.4			
			48	3.0	18.5	17.5	16.7	0.7	l/
82 0.10g., Al,Ag,Cu,S.S.,Ti	396.8	260° (500°)	6	2.3	3.6	2.8			
			48	3.6	37.9	34.6	33.3	0.8	m/
82 0.10g.,Al,Ag,Cu,S.S.,Ti	397.2	260° (500°)	6	1.5	3.2	2.8			
			48	1.3	20.5	19.3	18.9	1.0	n/
82 0.10g., Al,Ag,Cu,S.S.,Ti	396.9	260° (500°)	24	0.04	9.9	8.9	8.8	0.5	o/
82 0.20g.,Al,Ag,Cu,S.S.,Ti	400.4	260° (500°)	48	4.5	65.8	60.8	55.8	1.0	p/



Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
Morgan's Base, No. 375, 0.05g., Al,Ag,Cu,S.S.,Ti	406.6	260° (500°)	48	3.1	15.6	14.5	13.5	0.8	q/
0.075g.,Al,Ag,Cu,S.S.,Ti	406.7	260° (500°)	48	3.0	10.5	10.6	9.0	0.6	r/



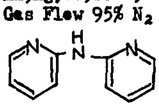
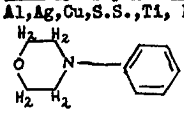
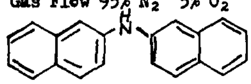
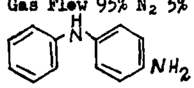
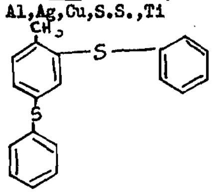
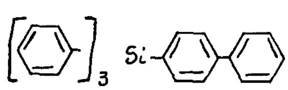
Metal Effects, Weight Loss, mg/cm²

a/ Al 0.06 Ag 0.50 Cu 1.02 S.S. 0.02 Ti 0.02
b/ Al 0.12 Ag 0.40 Cu 1.54 S.S. 0.22 Ti 0.16
c/ Al 0.04 Ag 0.30 Cu 0.90 S.S. 0.02 Ti 0.00
d/ Al 0.02 Ag 0.12 Cu 0.82 S.S. 0.02 Ti 0.00
e/ Al 0.14 Ag 0.20 Cu 1.04 S.S. 0.10 Ti 0.08
f/ Al 0.04 Ag 0.22 Cu 0.60 S.S. 0.00 Ti 0.00
g/ Al-0.24 Ag-0.10 Cu 0.58 S.S.-1.76 Ti-0.28
h/ Al-0.12 Ag 0.00 Cu 0.08 S.S.-0.16 Ti 0.00
i/ Al 0.46 Ag 0.54 Cu 0.96 S.S. 0.22 Ti 0.22
j/ Al 0.32 Ag 0.04 Cu 0.34 S.S. 0.10 Ti 0.00
k/ Al 0.42 Ag 0.36 Cu 1.28 S.S. 0.24 Ti 0.10
l/ Al 0.02 Ag 0.62 Cu 0.88 S.S. 0.00 Ti 0.00
m/ Al 0.04 Ag 0.72 Cu 0.92 S.S. 0.02 Ti 0.02
n/ Al 0.10 Ag 0.22 Cu 0.66 S.S. 0.16 Ti 0.16
o/ Al 0.12 Ag 0.24 Cu 0.90 S.S. 0.00 Ti 0.00
p/ Al 0.14 Ag 0.16 Cu-0.06 S.S.-0.14 Ti-0.24
q/ Al 0.30 Ag 0.20 Cu 0.78 S.S. 0.06 Ti 0.06
r/ Al 0.22 Ag 0.16 Cu 0.68 S.S. 0.14 Ti 0.04

1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
2/ These values are tabulated in a separate table, Table 6.

Table 5 . Oxidations in Fluid F-50 (Cont'd)

Sample 25 ml

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, 2/ %
2,2'-Dipyridylamine, 0.05g. 1/ Al,Ag,Cu,S.S.,Ti, No. 128 Gas Flow 95% N_2 5% O_2 	409.8	316° (600°)	12	5.0	71.7	70.0	74.0	1.3	a/
N-Phenylmorpholine, 0.10g. Al,Ag,Cu,S.S.,Ti, No. 141 	406.10	260° (500°)	48	4.1	170.0	158.0	145.0	0.6	b/
Di-2-naphthylamine, No. 383, 0.05 g., Al,Ag, Cu,S.S.,Ti Gas Flow 95% N_2 5% O_2 	409.9	316° (600°)	12	5.2	149.0	144.0	144.0	1.2	c/
p-Aminodiphenylamine, No. 360, 0.10g.,Al,Ag,Cu,S.S.,Ti	396.10	260° (500°)	24	1.6	5.6	5.6	6.0	0.6	d/
0.05g. Al,Ag,Cu,S.S.,Ti Gas Flow 95% N_2 5% O_2 	409.7	316° (600°)	12	3.6	98.0	99.5	99.0	0.9	e/
2,4-Bis-(phenylmercapto) toluene, No. 372, 0.20 ml. Al,Ag,Cu,S.S.,Ti 	406.8	260° (500°)	48	3.6	31.2	28.8	19.0	0.6	f/
Triphenyl-p-phenylylsilane, Tech., No. 356, 0.10g. Al,Ag,Cu,S.S.,Ti 	406.9	260° (500°)	48	25.2	N.M.			N.M.	g/

Metal Effects, Weight Loss, mg/cm²

a/ Al 0.28 Ag 0.04 Cu 0.70 S.S. 0.36 Ti 0.02
b/ Al 0.76 Ag 0.10 Cu 0.78 S.S. 0.06 Ti 0.08
c/ Al 0.06 Ag 0.10 Cu 1.06 S.S. 0.60 Ti 0.00
d/ Al 0.04 Ag 0.38 Cu 1.08 S.S. 0.02 Ti 0.00
e/ Al 0.10 Ag 0.02 Cu 0.28 S.S. 0.44 Ti 0.02
f/ Al 0.22 Ag 0.26 Cu 2.88 S.S. 0.08 Ti 0.06
g/ Al 0.38 Ag 0.08 Cu 2.18 S.S. 0.02 Ti 0.04

N.M. Too viscous to measure.

1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
2/ These values are tabulated in a separate table, Table 6.

TABLE 6

Behavior of Insolubles in Oxidized F-50 Blend

Additive, CCL No. and Concentration Metals Present	Run No.	Time Hours	Temperature °C (°F)	Percentage Insoluble			
				Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
None, Al,Ag,Cu,S.S.,Ti	396.1	24	260° (500°)	1.03	0.03	0.03	0.00
None, Al,Ag,Cu,S.S.,Ti	397.1	24	260° (500°)	Gel.			
None, Al,Ag,Cu,S.S.,Ti	396.2	48	260° (500°)	Gel.			
None, Al,Ag,Cu,S.S.,Ti	409.5	12	316° (600°)	5.86	0.42	0.30	10.00
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Al,Ag,Cu,S.S.,Ti	404.1	48	260° (500°)	0.41	N.D.	N.D.	0.09
260 0.020g.,Al,Ag,Cu,S.S.,Ti	404.2	48	260° (500°)	0.81	0.02	0.02	0.21
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.3	48	260° (500°)	0.62	0.03	0.03	0.08
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.4	48	260° (500°)	0.71	0.04	0.03	0.31
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.5	48	260° (500°)	0.66	0.03	0.03	0.09
260 0.025g.,Al,Ag,Cu,S.S.,Ti	396.6	24	260° (500°)	1.13	0.04	0.04	0.20
260 0.025g.,Al,Ag,Cu,S.S.,Ti	397.5	48	260° (500°)	0.70	0.02	0.01	0.24
260 0.010g.,Al,Ag,Cu,S.S.,Ti	398.3	48	260° (500°)	0.76	0.01	0.01	0.12
260 0.03g., Al,Ag,Cu,S.S.,Ti	402.1	6	260° (500°)	0.92	0.00	0.00	0.28
260 0.03g., Al,Ag,Cu,S.S.,Ti	402.2	12	260° (500°)	2.47	0.05	0.03	0.28
260 0.03g., Al,Ag,Cu,S.S.,Ti	402.3	18	260° (500°)	1.56	0.02	0.00	0.19
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.4	24	260° (500°)	1.41	0.02	0.00	0.15
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.5	30	260° (500°)	1.09	0.01	0.00	0.21
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.6	36	260° (500°)	1.39	0.00	0.00	0.23
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.7	42	260° (500°)	1.48	0.00	0.00	0.11
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.8	48	260° (500°)	1.66	0.00	0.00	0.14
260 0.03g.,Al,Ag,Cu,S.S.,Ti	404.3	48	260° (500°)	0.59	0.03	0.03	0.43
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.9	54	260° (500°)	1.08	0.00	0.00	0.12
260 0.03g.,Al,Ag,Cu,S.S.,Ti	402.10	60	260° (500°)	1.69	0.00	0.00	0.09
260 0.03g.,Al,Ag,Cu,S.S.,Ti	409.6	12	316° (600°)	4.20	0.29	0.22	5.71
260 0.04g.,Al,Ag,Cu,S.S.,Ti	404.4	48	260° (500°)	0.92	0.08	0.01	0.55
260 0.05g.,Al,Ag,Cu,S.S.,Ti	400.1	48	260° (500°)	0.92	0.02	0.02	0.34
260 0.05g.,Al,Ag,Cu,S.S.,Ti	404.5	48	260° (500°)	1.34	0.03	0.01	0.57
260 0.05g.,Al,Ag,Cu,S.S.,Ti	406.1	48	260° (500°)	0.62	0.04	0.02	1.28
260 0.075g.,Al,Ag,Cu,S.S.,Ti	404.6	48	260° (500°)	0.80	0.00	0.00	0.57
260 0.10g.,Al,Ag,Cu,S.S.,Ti	404.7	48	260° (500°)	1.03	0.06	0.05	0.60
260 0.15g.,Al,Ag,Cu,S.S.,Ti	404.8	48	260° (500°)	1.53	0.22	0.16	0.63
260 0.20g, Al,Ag,Cu,S.S.,Ti	400.5	48	260° (500°)	1.82	0.01	0.00	0.21
260 0.20g.,Al,Ag,Cu,S.S.,Ti	406.2	48	260° (500°)	1.21	0.42	0.40	1.75
260 0.40g.,Al,Ag,Cu,S.S.,Ti	406.3	48	260° (500°)	2.40	1.33	1.33	2.64
N,N'-Dicyclohexyl-p-phenylenediamine, No. 350, 0.010g.,Al,Ag,Cu,S.S.,Ti	398.2	48	260° (500°)	Not Filterable			
350 0.030g.,Al,Ag,Cu,S.S.,Ti	398.1	48	260° (500°)	0.93	0.01	0.01	2.56

Table 6. Behavior of Insolubles in Oxidized F-50 Blend. (Cont'd)

Additive, CCL No., and Concentration Metals Present	Run No.	Time Hours	Temperature °C (°F)	Percentage Insoluble			
				Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.025g. and Acridine, No. 82, 0.025g., Al,Ag,Cu,S.S.,Ti	400.7	48	260° (500°)	1.35	0.17	0.16	0.25
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.050g., and N-Phenylmorpholine, No. 141, 0.005g., Al,Ag,Cu,S.S.,Ti	400.9	48	260° (500°)	0.91	0.02	0.00	0.29
260 0.010g. and 141 0.010g. Al,Ag,Cu,S.S.,Ti	404.10	48	260° (500°)	1.66	0.00	0.00	0.15
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Acridine, No. 82, 0.010g., and Diphenylguanidine, No. 161, 0.010g., Al,Ag,Cu,S.S.,Ti	400.8	48	260° (500°)	Gel			
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.010g., Acridine, No. 82, 0.010g., and N-Phenylmorpholine, No. 141, 0.010g., Al,Ag,Cu,S.S.,Ti	404.9	48	260° (500°)	2.02	0.02	0.02	0.16
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, and N-Aminoethylmorpholine, No. 117, 0.005g.	400.10	48	260° (500°)	1.44	0.14	0.12	0.14
Diphenylguanidine, No. 161, 0.05g. Al,Ag,Cu,S.S.,Ti	396.13	48	260° (500°)	0.99	0.02	0.01	0.83
161 0.05g., Al,Ag,Cu,S.S.,Ti	397.3	48	260° (500°)	0.89	0.02	0.01	0.26
161 0.10g., Al,Ag,Cu,S.S.,Ti	396.14	48	260° (500°)	2.33	1.44	1.43	2.22
161 0.05g. Al,Ag,Cu,S.S.,Ti	396.11	24	260° (500°)	1.00	0.04	0.04	0.28
161 0.05g. Al,Ag,Cu,S.S.,Ti	397.4	24	260° (500°)	0.53	0.02	0.01	0.18
161 0.10g.,Al,Ag,Cu,S.S.,Ti	396.12	24	260° (500°)	0.87	0.04	0.03	1.34
161 0.20g.,Al,Ag,Cu,S.S.,Ti	400.6	48	260° (500°)	0.93	0.06	0.04	0.32
Acridine, No. 82, 0.05g. Al,Ag,Cu,S.S.,Ti	400.2	48	260° (500°)	1.22	0.00	0.00	0.13
82 0.05g., Al,Ag,Cu,S.S.,Ti	406.4	48	260° (500°)	0.56	0.00	0.00	1.92
82 0.075g., Al,Ag,Cu,S.S.,Ti	406.5	48	260° (500°)	0.66	0.00	0.00	1.79
82 0.10g.,Al,Ag,Cu,S.S.,Ti	396.7	48	260° (500°)	0.77	0.02	0.01	0.15
82 0.10g.,Al,Ag,Cu,S.S.,Ti	396.8	48	260° (500°)	0.71	0.02	0.01	0.10
82 0.10g., Al,Ag,Cu,S.S.,Ti	397.2	48	260° 500°)	0.66	0.03	0.01	0.52
82 0.10g., Al,Ag,Cu,S.S.,Ti	396.9	24	260° (500°)	1.03	0.03	0.01	0.10
82 0.20g., Al,Ag,Cu,S.S.,Ti	400.4	48	260° (500°)	1.37	0.02	0.00	0.16
82 0.05g., Al,Ag,Cu,S.S.,Ti	409.10	12	316° (600°)	4.82	0.36	0.24	3.51
Morgan's Base, No. 375, 0.05g. Al,Ag,Cu,S.S.,Ti	406.6	48	260° (500°)	0.62	0.02	0.00	2.70
No. 375 0.075g., Al,Ag,Cu,S.S.,Ti	406.7	48	260° (500°)	0.96	0.05	0.01	3.28
2,2'-Dipyridylamine, No. 128, 0.05g., Al,Ag,Cu,S.S.,Ti	409.8	12	316° (600°)	3.68	0.41	0.28	6.83

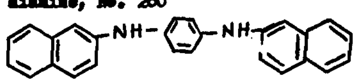
Table 6. Behavior of Insolubles in Oxidized F-50 Blend. (Cont'd).

Additive, CCL No., and Concentration Metals Present	Run No.	Time Hours	Temperature °C (°F)	Percentage Insoluble			
				Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
N-Phenylmorpholine, No. 141, 0.10g. Al,Ag,Cu,S.S.,Ti	406.10	48	260° (500°)	1.38	0.01	0.00	2.71
Di-2-naphthylamine, No. 383, 0.05g., Al,Ag,Cu,S.S.,Ti	409.9	12	316° (600°)	4.40	0.36	0.28	2.69
p-Aminodiphenylamine, No. 360, 0.05g. Al,Ag,Cu,S.S.,Ti	409.7	12	316° (600°)	4.79	0.36	0.28	3.68
360 0.10g., Al,Ag,Cu,S.S.,Ti	396.10	24	260° (500°)	1.23	0.13	0.13	0.10.
2,4-bis(phenyl mercapto)-toluene, No. 372 0.20g., Al,Ag,Cu,S.S.,Ti	406.8	48	260° (500°)	1.27	0.00	0.00	5.41
Triphenyl-p-phenylylsilane, Tech., No. 356, 0.10g., Al,Ag,Cu,S.S.,Ti	406.9	48	260° (500°)	Gel			

TABLE 7

Oxidations in G. E. Silicone Fluid No. 81406 (MLO 53-446)

25 ml. Sample

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %. 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
None, No Metals 2/	338.5	260° (500°)	24	3.2	76	71	N.D.	0.8	0.1
None, No Metals 2/	339.5	260° (500°)	48	5.1	Solid			N.M.	N.M.
None, No Metals 2/	335.2	316° (600°)	12	2.3	50	46		2.2	0.1
None, Al, Ag, Cu, S.S., Ti 2/	338.9	260° (500°)	24	3.4	93	87		0.8	0.02 a/
None, Al, Ag, Cu, S.S.,Ti 2/	339.9	260° (500°)	48	22.9	Solid			N.M.	N.M. b/
None, Al, Ag, Cu, S.S.,Ti 2/	335.3	316° (600°)	12	3.6	82	79		3.1	0.1 c/
N,N'-Di-2-Naphthyl-p-phenylenediamine, No. 260 									
0.005 g., Al, Ag,Cu,S.S.,Ti 2/	349.5	260° (500°)	24	2.1	16	15	16	1.0	0.02 d/
0.005 g., Al, Ag,Cu,S.S.,Ti 1/	355.1	260° (500°)	24	3.5	50	47	53	3.5	0.00 e/
0.005 g., Al, Ag,Cu,S.S.,Ti 2/	349.10	260° (500°)	48	2.8	30	28	30	1.0	0.14 f/
0.01 g., Al, Ag,Cu,S.S.,Ti 1/	355.2	260° (500°)	24	2.2	19	18	18	2.2	0.02 g/
0.025 g., Al, Ag,Cu,S.S.,Ti 1/	355.3	260° (500°)	24	1.3	4	4	3	1.3	1.1 h/
0.025g., Al, Ag,Cu,S.S.,Ti 1/	355.5	260° (500)	48	5.2	12	11	9	5.2	0.6 i/
0.025 g.,Al,Ag,Cu,S.S.,Ti 2/	350.9	316° (600°)	12	4.9	111	108	N.M.	1.6	1.4 j/
0.025 g., Al,Ag,Cu,S.S.,Ti 2/	350.10	316° (600°)	24	4.5	985	N.D.	N.M.	1.1	0.10 k/
0.050 g., Al,Ag,Cu,S.S.,Ti 1/	355.4	260° (500°)	24	1.9	5	5	4	1.9	0.7 l/
0.050 g., Al,Ag,Cu,S.S.,Ti 1/	355.6	260° (500°)	48	2.5	9	9	7	2.5	5.0 m/
0.050 g., Al,Ag,Cu,S.S.,Ti 1/ (purified No. 260)	357.1	260° (500°)	48	3.1	12	12	9	0.6	0.08 n/
0.050 g., Al,Ag,Cu,S.S.,Ti 1/	357.2	260° (500°)	48	2.7	12	12	10	0.7	0.12 o/

1/ Gas Flow 1/hr. - Air
2/ Gas Flow 1/hr. - 95% N_2 - 5% O_2

Metal Effect, Weight Loss, mg/cm²
a/ Al 0.34 Ag 1.10 Cu 0.96 S.S. 0.50 Ti-0.08
b/ Al 0.18 Ag 1.22 Cu 2.96 S.S. 0.74 Ti 0.00
c/ Al 0.88 Ag 0.54 Cu 1.40 S.S. 0.88 Ti 0.12
d/ Al 0.04 Ag 0.36 Cu 0.84 S.S. 0.04 Ti 0.00
e/ Al 0.10 Ag 0.46 Cu 0.94 S.S. 0.16 Ti 0.12

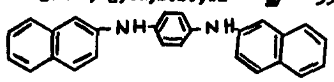
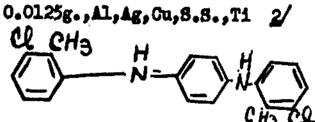
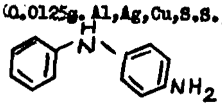
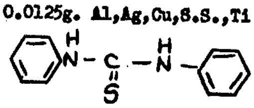
Metal Effect, Weight Loss, Mg/cm²
f/ Al 0.26 Ag 0.52 Cu 0.94 S.S. 0.26 Ti 0.10
g/ Al 0.18 Ag 0.44 Cu 1.58 S.S. 0.10 Ti 0.04
h/ Al 0.12 Ag 0.42 Cu 1.24 S.S. 0.34 Ti 0.16
i/ Al 0.06 Ag 0.28 Cu 1.06 S.S. 0.04 Ti 0.02
j/ Al 0.24 Ag 0.58 Cu 1.00 S.S. 0.66 Ti 0.08
k/ Al 0.18 Ag 0.30 Cu 1.24 S.S. 1.04 Ti 0.02
l/ Al 0.04 Ag 0.36 Cu 1.38 S.S. 0.00 Ti 0.10
m/ Al 0.08 Ag 0.16 Cu 1.30 S.S.-0.04 Ti 0.04

Metal Effect, Weight Loss, mg/cm²
n/ Al 0.04 Ag 0.18 Cu 0.96 S.S. 0.08 Ti 0.14
o/ Al 0.20 Ag 0.48 Cu 1.48 S.S. 0.14 Ti 0.04

N.D. Not Determined.
N.M. Too Viscous for measurement.

Table 7. Oxidations in G. E. Silicone Fluid No. 81406 (MLO 53-446) (Cont'd)

25 ml Sample.

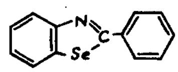
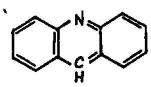
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %. 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
N,N'-Di-2-Naphthyl-p-phenylenediamine, No. 260, (Cont'd) 0.10 g. Al,Ag,Cu,S.S.,Ti 1/	355.7	260°C (500°F)	48	6.0	9	9	6	6.0	0.5 a/
0.10 g. Al,Ag,Cu,Cr-Mo,Ti 1/	355.9	260°C (500°F)	24	2.9	5	5	4	2.9	0.8 b/
0.10 g.Al,Ag,Cu,Cr-Mo,Ti 1/	355.10	260°C (500°F)	48	2.6	10	10	9	2.6	0.8 c/
0.25g. Al,Ag,Cu,S.S.,Ti 1/ 	355.8	260°C (500°F)	48	7.1	10	10	8	7.1	0.8 d/
N,N'-Di-(2-methyl-3-chlorophenyl-p-phenylenediamine, No. 350 0.0125g., Al,Ag,Cu,S.S.,Ti 2/	349.2	260°C (500°F)	24	2.1	13	12	12	1.0	0.02 e/
0.0125g.,Al,Ag,Cu,S.S.,Ti 2/ 	349.7	260°C (500°F)	48	2.4	23	22	23	1.3	0.02 f/
p-Aminodiphenylamine, No. 360 0.0125g., Al,Ag,Cu,S.S.,Ti 2/	349.3	260°C (500°F)	24	2.2	26	24	28	1.1	0.02 g/
0.0125g. Al,Ag,Cu,S.S.,Ti 2/ 	349.8	260°C (500°F)	48	3.1	66	61	70	0.8	0.04 h/
Thiocarbanilide, No. 332 0.0125g, Al,Ag,Cu,S.S.,Ti 2/	349.1	260°C (500°F)	24	2.9	58	54	59	2.1	0.00 i/
0.0125g. Al,Ag,Cu,S.S.,Ti 2/ 	349.6	260°C (500°F)	48	3.7	120	114	127	1.0	0.00 j/
Stannous naphthenate, No. 373 0.005g., Al,Ag,Cu,S.S.,Ti 2/	349.4	260°C (500°F)	24	2.3	62	58	74	0.9	0.1 k/
0.005g., Al,Ag,Cu,S.S.,Ti 2/	349.9	260°C (500°F)	48	3.5	119	112	162	1.1	0.0 l/

1/ Gas Flow 1 1/hr.- Air
2/ Gas Flow 1 1/hr.- 95% N_2, 5% O_2.
Metal Effect, Weight Loss, mg/cm^2
a/ Al 0.02 Ag 0.40 Cu 1.20 S.S. 0.06 Ti 0.02
b/ Al 0.10 Ag 0.22 Cu 1.18 Cr-Mo 0.32 Ti 0.12
c/ Al 0.02 Ag 0.52 Cu 1.68 Cr-Mo 0.14 Ti 0.04
d/ Al 0.04 Ag 0.46 Cu 1.44 S.S. 0.02 Ti-0.08
e/ Al 0.00 Ag 0.30 Cu 1.38 S.S. 0.12 Ti 0.10
f/ Al 0.04 Ag 0.48 Cu 0.84 S.S. 0.06 Ti 0.02
g/ Al 0.00 Ag 0.52 Cu 0.72 S.S. 0.18 Ti 0.00
h/ Al 0.00 Ag 0.90 Cu 1.00 S.S. 0.32 Ti 0.16
i/ Al 0.14 Ag 0.84 Cu 1.26 S.S. 0.58 Ti 0.14
j/ Al 0.10 Ag 0.92 Cu 1.56 S.S. 0.56 Ti 0.04
k/ Al 0.06 Ag 0.88 Cu 0.86 S.S. 0.48 Ti 0.04
l/ Al 0.12 Ag 0.74 Cu 1.04 S.S. 0.36 Ti 0.08
N.D. Not yet determined.

TABLE 8

Oxidations in Didodecyl Dioctyl Silane, MLO 57-161

Sample 25 ml. Air Flow 1 l/Hr.

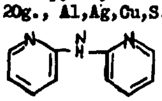
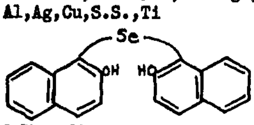
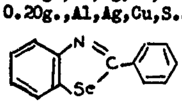
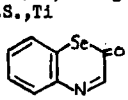
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %. 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, W[1]	P[1]
None, No Metals	420.1	260° (500°)	48	5.2	70.0	51.8	38.4	11.8	0.04	0.02
None, No Metals	421.2	260° (500°)	48	6.8	70.7	50.3	45.3	2.8	0.01	0.52
None, Al Ag Cu S.S. Ti 0.20 .14 .80 .16 .18 .04 .06 .12 .10 .04	420.4	260° (500°)	48	4.9	49.2	44.1	34.4	3.6	0.09	0.11
None, Al Ag Cu S.S. Ti 0.18 .20 .34 .36 .02 .10 .16 .06 .12 .02	421.5	260° (500°)	48	10.1	117.0	88.8	65.0	4.4	0.05	0.51
Phenyl selenide, No. 282PCB, 0.20g. Al Ag Cu S.S. Ti 0.22 .28 3.74 1.26 .12 .22 .70 .98 .86 .18	421.8	260° (500°)	48	6.9	53.8	41.2	31.0	2.0	0.09	0.71
$(C_6H_5)_2Se$										
2-Phenylbenzoselenazole, No. 300B, 0.20g., Al Ag Cu S.S. Ti 0.66 .34 1.42 .28 .28 .04 .12 .16 .00 .02	420.7	260° (500°)	48	4.2	43.8	34.9	29.7	4.0	0.14	0.16
300B, 0.30g. Al Ag Cu S.S. Ti 0.24 .20 .76 .78 .06 .14 .30 .20 .06 .14	421.7	260° (500°)	48	5.6	51.5	41.2	35.5	5.8	0.07	0.49
										
Acridine, No. 82, 0.24g. Al Ag Cu S.S. Ti 0.74 .36 .68 .82 .28 .22 .30 .28 .12 .20	421.9	260° (500°)	48	4.4	67.7	53.7	37.9	0.8	0.13	0.60
										
Copper sebacate-2,2'-dipyridyl-amine (Complex), No. 395, 0.30g. Al Ag Cu S.S. Ti 0.18 .12 1.40 .80 -.26 .10 .28 .32 .42 .36	421.10	260° (500°)	48	7.3	191.5	180.0	126.0	2.1	N.F.	N.F.

The Values under W are the per cent oil insoluble after the isooctane wash. The values under P are the per cent solid precipitated by oxidation of isooctane to the filtered fluid.

N.F. Not Filterable.

TABLE 9

Oxidations in Di-n-Dodecyl Di-n-Octyl Silane, MLO 56-611

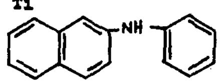
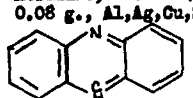
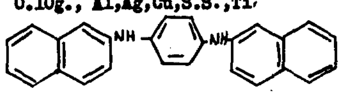
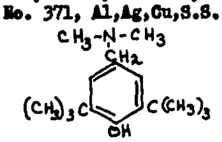
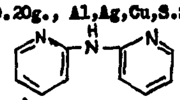
Additive, CCL No., Formula, Concentration, Metals Present 1/	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
None, No Metals	420.2	260° (500°)	48	5.1	52.5	40.4	31.1	5.1	0.20
None, No Metals	421.3	260° (500°)	48	5.2	45.7	36.2	28.4	2.8	0.53
None, Al,Ag,Cu,S.S.,Ti	420.5	260° (500°)	48	7.7	113.6	86.4	64.7	4.1	0.79 n/
None, Al,Ag,Cu,S.S.,Ti	421.6	260° (500°)	48	5.3	65.5	49.8	36.8	3.6	0.63 o/
None, Al,Ag,Cu,Cr-Mo,Ti	361.10	a/	36	4.2	45.5	34.4	N.D.	3.7	0.1 c/
None, Al,Ag,Cu,S.S.,Ti	364.10	b/	48	6.4	38.4	31.6	N.D.	2.1	0.1 d/
2,2'-Dipyridylamine, No. 128, 0.20g., Al,Ag,Cu,S.S.,Ti 	359.10	260°C (500°F)	48	4.8	62.0	53.0	N.D.	4.6	6.9 e/
Phenyl selenide, No. 282 PCB, 0.20g., Al,Ag,Cu,S.S. Ti $(C_6H_5)_2Se$	359.6	260°C (500°F)	48	7.5	51.4	39.8	N.D.	6.6	0.2 f/
Di-(2-hydroxy-1-naphthyl) selenide, No. 307, 0.20g., Al,Ag,Cu,S.S.,Ti 	359.8	260°C (500°F)	48	6.2	47.8	37.1	N.D.	2.8	0.2 f/
2-Phenylbenzoselenazole, No. 300B, 0.20g., Al,Ag, Cu,S.S.,Ti	359.7	260°C (500°F)	48	6.0	53.0	43.5	N.D.	5.3	0.2 g/
0.10g.,Al,Ag,Cu,C.M.,Ti	361.9	a/	36	5.3	46.2	35.8	N.D.	3.4	0.2 h/
0.20g.,Al,Ag,Cu,S.S.,Ti	360.8	a/	36	4.6	36.7	29.2	N.D.	4.4	0.1 i/
0.40g.,Al,Ag,Cu,S.S.,Ti	360.9	a/	36	6.3	38.8	31.2	N.D.	5.4	0.1 j/
0.40g.,Al,Ag,Cu,Cr-Mo,Ti	360.10	a/	36	6.1	43.0	36.0	N.D.	4.0	0.2 k/
0.10g.,Al,Ag,Cu,S.S.,Ti	364.9	b/	48	8.4	52.7	43.3	N.D.	2.6	0.1 l/
0.20g.,Al,Ag,Cu,S.S.,Ti 	420.8	260° (500°)	48	6.1	55.7	42.3	31.8	5.0	0.2 p/
1,4,2-Benzoselenazin-3-one, No. 308, 0.20g.,Al,Ag,Cu, S.S.,Ti 	359.9	260°C (500°F)	48	6.2	52.0	40.7	N.D.	2.6	0.2 m/

a/ 24 hours with air at 260°C and 12 hours with 95% N_2 and 5% O_2 gas mixture at 316°C.
b/ 260°C for 24 hours, raised to 316°C for 12 hours, after 36 hours the temperature dropped back to 260°C for 12 hours with 95% N_2 and 5% O_2 gas mixture.
c/ Al 0.32 Ag 0.10 Cu 0.26 Cr-Mo 0.34 Ti 0.10
d/ Al 0.38 Ag 0.62 Cu 0.86 S.S. 0.50 Ti 0.10
e/ Al 0.08 Ag 0.08 Cu 1.34 S.S. 0.86 Ti 0.22
f/ Al 0.16 Ag 0.40 Cu 2.28 S.S. 2.44 Ti 0.10
g/ Al 0.10 Ag 0.10 Cu 0.70 S.S. 0.30 Ti 0.00
h/ Al 0.64 Ag 0.10 Cu 0.62 Cr-Mo 0.24 Ti 0.24
i/ Al 0.52 Ag 0.40 Cu 0.62 S.S. 0.56 Ti 0.30
j/ Al 0.30 Ag 0.32 Cu 0.84 S.S. 0.86 Ti 0.46
k/ Al 0.00 Ag 0.46 Cu 1.68 Cr-Mo 1.84 Ti 0.64
l/ Al 0.12 Ag 0.36 Cu 0.90 S.S. 0.48 Ti 0.18
m/ Al 0.32 Ag 1.28 Cu 6.42 S.S. 1.46 Ti 0.00
n/ Al 0.44 Ag 0.10 Cu 1.36 S.S. 0.32 Ti 0.18
o/ Al 0.36 Ag 0.06 Cu 0.56 S.S. 0.46 Ti 0.18
p/ Al 0.38 Ag 0.30 Cu 1.44 S.S. 0.46 Ti 0.18

1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.

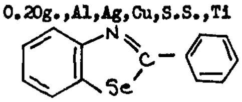
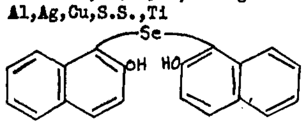
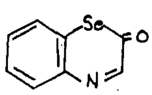
N.D. Not yet determined.

TABLE 10
Oxidations in n-Octadecyl-tri-n-Octyl Silane, MLO 56-578

Additive, CCL No., Formula, Concentration, Metals Present 1/	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
None, No Metals	420.3	260° (500°)	48	7.4	52.5	40.5	57.4	7.6	0.17
None, No Metals	421.1	260° (500°)	48	8.4	93.5	70.0	53.0	3.3	0.53
None, Al,Ag,Cu,S.S.,Ti	420.6	260° (500°)	48	6.7	85.5	63.6	47.7	5.5	0.17 p/
None,Al,Ag,Cu,S.S.,Ti	421.4	260° (500°)	48	6.8	70.2	52.3	38.1	3.9	0.60 q/
None, Al,Ag,Cu, S.S.,Ti	356.6	260°C (500°F)	24	8.9	104.0	79.4	N.D.	4.4	0.3 c/
None, Al,Ag,Cu,S.S.,Ti	356.7	260°C (500°C)	48	11.9	203.0	149.5	N.D.	5.3	0.1 d/
None, Al,Ag,Cu,Cr-Mo,Ti	361.8	a/	36	5.2	56.3	41.0	N.D.	4.5	0.2 e/
None, Al,Ag,Cu,S.S.,Ti	364.8	b/	48	10.2	68.5	54.0	N.D.	2.3	0.2 f/
Phenyl-alpha-naphthylamine, No. 61, 0.10g.,Al,Ag,Cu,S.S., Ti 	357.10	260°C (500°F)	48	10.5	111.0	83.5	N.D.	5.1	0.3 g/
Acridine, No. 82 (recryst.), 0.08 g., Al,Ag,Cu,S.S.,Ti 	356.9	260° C (500°F)	48	14.5	491.0	299.0	N.D.	3.6	0.1 h/
N,N'-Di-2-naphthyl-p-phenylenediamine, No. 260, 0.10g., Al,Ag,Cu,S.S.,Ti 	356.10	260°C (500°F)	48	14.5	1000.0	592.0	N.D.	3.8	0.2 i/
4-Hydroxy-3,5-ditert.-butyl benzyl dimethylamine, No. 371, Al,Ag,Cu,S.S.,Ti 	356.8	260°C (500°F)	48	14.2	405.0	285.0	N.D.	3.8	0.2 j/
2,2'-Dipyridylamine, No. 128, 0.10g., Al,Ag,Cu,S.S.,Ti	357.7	260°C (500°F)	48	8.2	77.0	59.3	N.D.	4.8	0.3 k/
0.20g., Al,Ag,Cu,S.S.,Ti 	359.5	260°C (500°F)	48	8.5	173.0	126.0	N.D.	2.3	0.3 l/
2,2'-Dipyridylamine, No. 128, 0.10g. and Diphenyl selenide, No. 282PCB, 0.10g., Al,Ag,Cu,S.S.,Ti $(C_6H_5)_2Se$	357.8	260°C (500°F)	48	5.9	95.0	70.5	N.D.	2.9	0.2 m/
Diphenyl selenide, No. 282PCB 0.10 g., Al,Ag,Cu,S.S.,Ti	357.9	260°C (500°F)	48	7.5	60.0	43.8	N.D.	3.4	0.2 n/
0.20 g., Al,Ag,Cu,S.S.,Ti	359.1	260°C (500°F)	48	8.9	63.3	48.3	N.D.	2.3	0.2 o/

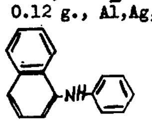
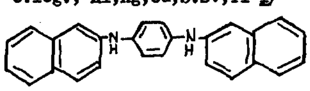
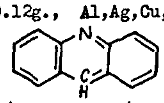
a/ 24 hours with air at 260°C and 12 hours with 95% N_2 - 5% O_2 gas mixture at 316°C.
b/ 260°C for 24 hours, raise the temperature to 316°C for 12 hours, after 36 hours drop the temperature back to 260°C for 12 hours with 95% N_2 - 5% O_2 gas mixture.
c/ Al 0.14 Ag 0.10 Cu 1.10 S.S. 0.08 Ti 0.14
d/ Al 0.08 Ag 0.06 Cu 0.44 S.S. 0.02 Ti-0.16
e/ Al 0.18 Ag 0.12 Cu 0.28 Cr-Mo 0.34 Ti 0.16
f/ Al 0.56 Ag 0.38 Cu 0.94 S.S. 0.38 Ti 0.10
g/ Al 0.24 Ag 0.22 Cu 1.46 S.S. 0.48 Ti 0.36
h/ Al 0.22 Ag 0.36 Cu 0.62 S.S. 0.02 Ti 0.16
i/ Al 0.20 Ag 0.28 Cu 1.00 S.S. 0.02 Ti 0.04
j/ Al 0.00 Ag 0.14 Cu 0.52 S.S. 0.00 Ti 0.08
k/ Al 0.24 Ag 0.32 Cu 1.08 S.S. 0.94 Ti 0.50
l/ Al 0.34 Ag 0.50 Cu 1.68 S.S. 0.78 Ti 0.00
m/ Al 0.34 Ag 0.72 Cu 4.80 S.S. 1.26 Ti 0.06
n/ Al 0.66 Ag 1.04 Cu 2.08 S.S. 1.68 Ti 0.00
o/ Al 0.32 Ag 0.00 Cu 6.38 S.S. 1.80 Ti 0.18
p/ Al 0.28 Ag 0.24 Cu 0.96 S.S. 0.76 Ti 0.30
q/ Al 0.02 Ag 0.16 Cu 0.20 S.S. 0.46 Ti 0.10
1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
N.D. Not yet determined.

Table 10. Oxidations in N-Octadecyl-tri-n-Octyl Silane, MLO 56-578 (Cont'd).

Additive, CCL No., Formula, Concentration, Metals Present 1/	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
2-Phenylbenzoselenazole, No. 300B, 0.20g., Al, Ag, Cu, S.S., Ti	359.2	260°C (500°F)	48	7.8	61.9	46.7	N.D.	4.3	0.1 c/
0.10g., Al, Ag, Cu, Cr-Mo, Ti	361.7	a/	36	4.9	46.2	34.0	N.D.	3.8	0.2 d/
0.20g., Al, Ag, Cu, S.S., Ti	360.5	a/	36	7.4	46.5	36.2	N.D.	4.3	0.1 e/
0.40g., Al, Ag, Cu, S.S., Ti	360.5	a/	36	6.7	47.5	37.2	N.D.	6.3	0.2 f/
0.40g., Al, Ag, Cu, Cr-Mo, Ti	360.7	a/	36	7.6	53.9	42.0	N.D.	4.4	0.3 g/
0.10g., Al, Ag, Cu, S.S., Ti	364.7	b/	48	10.4	65.3	52.0	N.D.	2.6	0.1 h/
0.20g., Al, Ag, Cu, S.S., Ti	420.9	260° (500°)	48	5.0	33.2	31.0	21.7	5.1	0.3 k/
									
Di-(2-hydroxy-1-naphthyl) selenide, No. 307, 0.20g. Al, Ag, Cu, S.S., Ti	359.3	260°C (500°F)	48	6.3	62.2	46.3	N.D.	2.6	0.1 i/
									
1,4,2-Benzoselenazin-3-one, No. 308, 0.20g., Al, Ag, Cu, S.S., Ti	359.4	260°C (500°F)	48	6.0	53.5	40.8	N.D.	2.4	0.3 j/
									

a/ 24 Hours with air at 260°C and 12 hours more with 95% N_2 - 5% O_2 at 316°C.
b/ 260°C for 24 hours, raise the temperature to 316°C for 12 hours, after 36 hours drop the temperature back to 260°C for 12 hours with 95% N_2 - 5% O_2 gas mixture.
Metal Effect, Weight Loss, mg/cm²
c/ Al 0.14 Ag 0.20 Cu 0.34 S.S. 0.16 Ti 0.00
d/ Al 0.54 Ag 0.28 Cu 0.52 Cr-Mo 0.50 Ti 0.24
e/ Al 0.34 Ag 0.42 Cu 0.48 S.S. 0.42 Ti 0.20
f/ Al 0.54 Ag 0.60 Cu 0.58 S.S. 0.64 Ti 0.12
g/ Al 0.60 Ag 0.56 Cu 1.00 Cr-MO 7.12 Ti 0.18
h/ Al 0.48 Ag 0.40 Cu 1.54 S.S. 0.42 Ti 0.12
i/ Al 0.04 Ag-0.66 Cu 9.92 S.S. 0.98 Ti 0.22
j/ Al 0.10 Ag 1.56 Cu 9.14 S.S. 1.10 Ti 0.08
k/ Al 0.56 Ag 0.52 Cu 1.50 S.S. 0.64 Ti 0.40
1/ Unless otherwise indicated the oxidations were performed with 25 ml of fluid with dry air passing at the rate of 1 l/hr.
N.D. Not yet determined.

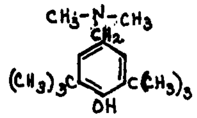
TABLE 11
Oxidations in Diphenyl Di-n-dodecyl Silane, MLO 56-280

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
None, Al, Ag,Cu,S.S.,Ti 1/	356.1	260°C (500°F)	24	10.5	107.0	85.5	N.D.	3.4	0.1 a/
None, Al,Ag,Cu,S.S.,Ti 1/	356.2	260°C (500°F)	48	15.1	865.0	528.0	N.D.	4.0	0.3 b/
None, No Metals 2/	352.1	316°C (600°F)	12	7.7	25.7	24.6	N.D.	2.7	0.1
None, No Metals 2/	353.9	316°C (600°F)	12	8.3	23.2	22.4	N.D.	1.5	0.1
None, No Metals 2/	352.2	316°C (600°F)	24	18.0	96.0	88.4	N.D.	3.0	0.1
None, 1 Al Square 1/	354.1	316°C (600°F)	12	8.3	37.0	31.0	N.D.	1.7	0.1 c/
None, 2 Al Squares 1/	354.2	316° 600°F)	12	9.7	46.0	38.0	N.D.	2.4	0.1 d/
None, Al, Ag,Cu,S.S.,Ti 2/	352.3	316° (600°F)	12	8.1	3.1	7.8	N.D.	1.9	0.1 e/
None, Al,Ag,Cu,S.S.,Ti 2/	353.10	316°C (600°F)	12	6.7	-4.2	0.8	N.D.	1.3	0.1 f/
None, Al,Ag,Cu,S.S.,Ti 2/	352.4	316°C (600°F)	24	11.4	13.0	16.7	N D.	1.1	0.2 g/
Phenyl-alpha-naphthylamine, No. 61, 0.12 g., Al,Ag,Cu, S.S., Ti 2/	352.7	316°C (600°F)	12	6.4	2.6	6.3	N.D.	1.4	0.1 h/
0.12 g., Al,Ag,Cu,S.S.,Ti 2/	352.8	316°C (600°F)	24	10.8	13.6	17.1	N.D.	1.4	0.2 i/
									
N,N'-Di-2-naphthyl-p-phenylenediamine, NO. 260 0.10g., Al,Ag,Cu,S.S.,Ti 1/	356.5	260°C (500°F)	48	18.4	N.M.			2.3	99.3 j/
									
Acridine, No. 82 (recryst.) 0.08 g., Al,Ag,Cu,S.S.,Ti 1/	356.4	260°C (500°F)	48	16.6	N.M			1.1	90.8 k/
0.12 g., Al,Ag,Cu,S.S.,Ti 2/	352.5	316°C (600°F)	12	7.5	9.2	12.1	N.D.	1.4	0.1 l/
0.12 g., Al,Ag,Cu,S.S.,Ti 1/	354.3	316°C (600°F)	12	12.9	61.0	57.0	N.D.	1.6	0.2 m/
0.12 g.,Al,Ag,Cu,S.S.,Ti 1/	354.5	316°C (600°F)	12	16.5	96.9	93.0	N.D.	1.5	0.1 n/
0.12 g., Al,Ag,Cu,S.S.,Ti 2/	352.6	316°C (600°F)	24	12.7	39.4	36.7	N.D.	1.7	0.2 o/
0.12 g., Al,Ag,Cu,S.S.,Ti 1/	354.4	316°C (600°F)	24	21.0	330.0	325.0	N.D.	1.5	0.2 p/
0.12g., Al,Ag,Cu,S.S.,Ti 1/	354.6	316°C (600°F)	24	25.9	N.M.	462.0	N.D.	1.3	0.2 q/
									

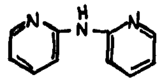
1/ Gas Flow 1/hr - Air
2/ Gas Flow 1/hr - 95% N_2 - 5% O_2
Metal Effect, Weight Loss, mg/cm^2
a/ Al 0.16 Ag 0.28 Cu 1.00 S.S. 0.16 Ti 0.02
b/ Al 0.30 Ag 0.18 Cu 0.96 S.S. 0.24 Ti 0.04
c/ Al 0.16
d/ Al 0.18 Al 0.36
e/ Al 19.2 Ag 0.00 Cu 0.22 S.S. 0.08 Ti 0.04
f/ Al 15.1 Ag 0.12 Cu 0.20 S.S. 0.00 Ti 0.14
g/ Al 25.9 Ag 0.12 Cu 0.14 S.S. 0.18 Ti 0.00
h/ Al 19.4 Ag 0.22 Cu 0.30 S.S. 0.04 Ti 0.08
i/ Al 25.2 Ag 0.10 Cu 0.52 S.S.-0.06 Ti 0.00
j/ Al 0.10 Ag 1.22 Cu 1.64 S.S. 0.20 Ti-0.04
k/ Al 0.16 Ag 1.16 Cu 3.04 S.S. 0.30 Ti 0.06
l/ Al 19.1 Ag 0.00 Cu 0.36 S.S. 0.12 Ti 0.10
m/ Al 1.70 Ag 0.56 Cu 1.04 S.S. 0.48 Ti 0.08
n/ Al 0.18 Ag 0.32 Cu 0.82 S.S. 0.38 Ti 0.04
o/ Al 18.1 Ag 0.04 Cu 0.62 S.S. 0.22 Ti 0.10
p/ Al 0.28 Ag 0.34 Cu 1.24 S.S. 0.56 Ti 0.04
q/ Al 0.24 Ag 1.08 Cu 3.58 S.S. 0.82 Ti 0.14
N.D. Not yet determined.

Table 11. Oxidations in Diphenyl Di-n-dodecyl Silane, MLO 56-280 (Cont'd)

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
4-Hydroxy-3,5-ditert.-butyl benzoyl dimethylamine, No. 371 0.12 g., Al,Ag,Cu,S.S.,Ti 1/	356.3	260°C (500°F)	48	12.7	N.M.			1.9	0.5 a/
0.12g. Al,Ag,Cu,S.S.,Ti 2/	352.9	316°C (600°F)	12	8.0	12.1	14.0	N.D.	1.5	0.1 b/
0.12g. Al,Ag,Cu,S.S.,Ti 2/	352.10	316°C (600°F)	24	10.1	11.4	15.5	N.D.	1.4	0.1 c/



Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
2,2'-Dipyridylamine, No. 128 0.10g., Al,Ag,Cu,S.S.,Ti 1/	357.5	260°C (500°F)	48	11.4	164.0	131.5	N.D.	1.6	7.4 d/



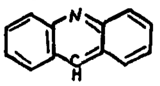
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	54.5°C (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
2,2'-Diphenylamine, No. 128 0.10g. and Diphenylselenide, No. 282PCB, 0.10g. Al,Ag,Cu,S.S.,Ti 1/ $(C_6H_5)_2Se$	357.6	260°C (500°F)	48	8.2	76.0	61.0	N.D.	1.4	4.9 e/

1/ Gas Flow 1/hr.-Air
2/ Gas Flow 1/hr. - 95% N_2 - 5% O_2
Metal Effect, Weight Loss, mg/cm²
a/ Al 1.34 Ag 0.84 Cu 1.66 S.S. 0.28 Ti 0.04
b/ Al 17.3 Ag 0.10 Cu 51.9 S.S. 0.06 Ti-0.14
c/ Al 1.34 Ag 0.84 Cu 1.66 S.S. 0.28 Ti 0.04
d/ Al 0.40 Ag 1.52 Cu 5.60 S.S. 2.52 Ti 0.64
e/ Al 0.36 Ag 1.88 Cu 7.03 S.S. 3.24 Ti 0.78

TABLE 12

Oxidations in Silicone MLO 9840, XF258 Gas Flow: 1/1 Hr. Air

Acridine, No. 82 recryst. 1/ 0.12g., Al,Ag,Cu,S.S.,Ti	354.7	316°C (600°F)	12	1.5	1.8	0.5	N.D.	1.6	0.1 a/
recryst. 0.12 g. Al,Ag,Cu, S.S.,Ti	354.8	316°C (600°F)	24	3.2	9.8	6.8	N.D.	1.0	0.1 b/
residue, 0.12 g. Al,Ag,Cu,S.S.,Ti	354.9	316°C (600°F)	12	3.1	25.8	23.0	N.D.	0.8	0.1 c/
residue, 0.12 g. Al, Ag,Cu,S.S.,Ti	354.10	316°C (600°F)	24	5.9	127.0	115.5	N.D.	1.1	0.02 d/

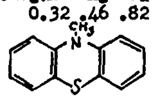
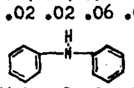
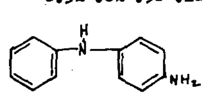


1/ The commercial sample was purified by recrystallization from alcohol. The first crop of crystals which appeared of good purity is labelled "recryst." The residue after removal of another crop of crystals and evaporation of solvent was labelled "residue".

Metal Effect, Weight Loss, mg/cm²
a/ Al 0.08 Ag 0.24 Cu 0.46 S.S. 0.12 Ti 0.14
b/ Al 0.04 Af 0.14 Cu 0.78 S.S. 0.10 Ti 0.00
c/ Al 0.00 Ag 0.46 Cu 0.64 S.S 0.00 Ti 0.04
d/ Al-0.04 Ag 0.22 Cu 0.48 S.S. 0.00 Ti 0.06
N.D. Not yet determined.

TABLE 13
Oxidations in a Pentaerythritol Ester, MLO 55-584

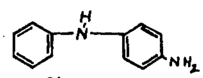
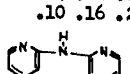
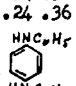
Sample 25 ml., Air Flow 1 l/Hr.

Additive, CCL No., Formula, Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
N-Methylphenothiazine, No.5, a/ 0.27g. Al Ag Cu S.S. Ti 0.00 .30 1.08 .12 .02	362.1	204°C (400°F)	60	3.9	23.1	17.6	N.D.	3.2	2.2
5 0.27g. Al Ag Cu S.S. Ti 0.36 .46 .76 .12 .18	365.10	204° (400°)	60	2.5	19.6	14.5	N.D.	3.7	1.3
5 0.27g. Al Ag Cu Cr-MO Ti 0.28 .20 .74 .12 .10	362.2	204° (400°)	60	3.9	21.5	15.0	N.D.	3.1	1.3
5, 0.27g. Al Ag Cu Cr-MO Ti 0.32 .46 .82 .96 .24	363.8	204° (400°)	60	2.6	17.7	12.0	N.D.	3.1	2.0
									
N-Methylphenothiazine, No.5, 0.27g. and Vanadyl 2-ethyl hexoate, No. 379, 0.02g. Al Ag Cu S.S. Ti 0.14 .32 3.66 .14 .06	362.7	204° (400°)	60	5.5	14.9	10.2	N.D.	37.7	3.8
N-Methylphenothiazine, No.5 0.27g. and Stannous naphthenate, No. 373, 0.02g. Al Ag Cu S.S. Ti 0.14 .24 .88 .18 .10	362.6	204° (400°)	60	5.3	21.6	15.5	N.D.	4.4	2.0
N-Methylphenothiazine, No.5, 0.27g. and Ferroscene, No. 374, 0.02g. Al Ag Cu S.S. Ti 0.00 .32 .98 .20 .08	362.8	204° (400°)	60	5.2	29.6	23.5	N.D.	14.9	4.2
5 0.15g. and 374 0.05g. Al Ag Cu S.S. Ti 0.42 .48 1.1 .26 .22	365.9	204° (400°)	60	3.7	18.8	12.4	N.D.	8.7	1.8
Diphenylamine, No. 52, 0.22g. Al Ag Cu S.S. Ti 0.02 -.04 .40 -.12 -.04 .00 .08 .04 .02 .00	413.9	204° (400°)	60	4.8	28.6	19.4	N.D.	4.1	0.9
52 0.22g. Al Ag Cu S.S. Ti 0.14 .04 .96 .22 .04 .02 .02 .06 .00 .00	414.9	260° (500°)	48	7.1	N.M.	N.M.	N.D.	7.1	N.F.
									
p-Aminodiphenylamine, No. 360, 0.25g. Al Ag Cu S.S. Ti 0.26 .44 .38 .10 .22	362.4	204° (400°)	60	6.5	11.9	7.9	N.D.	3.3	2.5
360 0.25g. Al Ag Cu S.S. Ti 0.00 .66 .38 .10 .20	374.10	204° (400°)	60	2.2	10.4	7.5	N.D.	2.2	1.2
360 0.24g. Al Ag Cu S.S. Ti -0.26 -16 -.14 -.22 -.16 .26 .18 .24 .04 .04	413.8	204° (400°)	60	6.1	9.9	6.2	N.D.	1.5	1.1
360 0.25g. Al Ag Cu S.S. Ti 0.26 .80 .82 .46 .24	375.10	232° (450°)	48	5.5	18.0	12.3	N.D.	14.9	2.8
360 0.25g. Al Ag Cu S.S. Ti 0.32 .62 .58 .18 .04	381.8	260° (500°)	24	5.8	15.2	10.0	N.D.	20.5	2.8
360 0.25g. Al Ag Cu S.S. Ti 0.02 .32 .50 .02 -.12	379.10	260° (500°)	36	8.9	37.3	28.9	N.D.	25.2	2.9
360 0.25g. Al Ag Cu S.S. Ti 0.32 .62 .58 .18 .04	380.6	260° (500°)	36	5.7	38.2	21.7	N.D.	22.0	3.0
									

N.D. Not Determined.
N.F. Not Filterable.
a/ At 500 F the phenothiazine type of additives in 1% concentration did not significantly retard the oxidation. In a 48 hour run the blank values for change in kinematic viscosity were over 200% and the neutralization numbers were above 25.

Table 13. Oxidations in a Pentaerythritol Ester, MLO 55-584 (Cont'd)

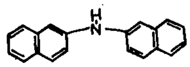
Sample 25 ml. Air Flow 1 l/hr.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %			Neutralization Number	Iso-octane Insoluble, %
					54.5°C (130°F)	100°C (212°F)	195°C (383°F)		
p-Aminodiphenylamine, No. 360, 0.25g. Al Ag Cu S.S. Ti -0.06 .32 .72 .00 .08	381.9	260°C (500°F)	36	5.7	22.6	16.7	N.D.	21.8	3.6
360 0.25g. Al Ag Cu S.S. Ti 0.26 .38 .48 .12 -.26	381.10	260° (500°)	48	5.1	15.8	10.7	N.D.	32.3	3.3
360 0.24g. Al Ag Cu S.S. Ti -0.22-.26 -.10-.16 -.40 .02 .00 .14 .00 .00	414.8	260° (500°)	48	6.7	25.2	17.2	N.D.	21.9	1.1
									
Isopropoxydiphenylamine, No. 390, 0.25g. Al Ag Cu S.S. Ti 0.14 .24 .70 .06 .06	374.9	204° (400°)	60	1.9	18.5	12.6	N.D.	5.6	0.9
390 0.25g. Al Ag Cu S.S. Ti 0.00 .24 1.12 .20 .18	375.9	232° (450°)	48	6.8	29.1	18.5	N.D.	23.6	2.9
380 0.25g. Al Ag Cu S.S. Ti 0.10 .18 1.50 .10 .06	379.9	260° (500°)	36	7.1	93.0	69.4	N.D.	32.8	5.9
2,2'-Dipyridylamine, No. 128, 0.22g. Al Ag Cu S.S. Ti -0.14.02 .86 .02 .04 .06.30 .12 .02 .02	413.10	204° (400°)	60	3.7	6.3	4.5	N.D.	1.0	0.2
128 0.25g. No Metals	367.5	260° (500°)	48	7.8.	N.M.	N.M.	N.D.	34.4	0.7
128 0.25g. Al Ag Ti 0.04 .06 -.12	367.8	260° (500°)	48	7.9	69.8	56.7	N.D.	28.2	0.8
128 0.25g. Al Cu Ti 0.00 2.38 -.04	367.7	260° (500°)	48	6.7	33.7	25.9	N.D.	28.1	10.9
128 0.25g. Al Ag Cu S.S. Ti 0.00 .08 .10 .64 -.22	367.6	260° (500°)	48	8.1	8.4	4.8	N.D.	24.0	1.7
128 0.22g. Al Ag Cu S.S. Ti -0.04 .02 .86 .02 .04 .10 .16 .22 .16 .00	414.10	260° (500°)	48	7.4	7.8	4.3	N.D.	7.4	0.3
									
N,N'-Diphenyl-p-phenylenediamine, No. 186, 0.34g. Al Ag Cu S.S. Ti -0.34-.38-.14 -.04 -.04 .24 .36 .24 .22 .32	422.5	204° (400°)	60	6.0	16.3	11.0	N.D.	2.0	1.3
									
o-Aminodiphenyl, No. 367, 0.25g. Al Ag Cu S.S. Ti 0.16 .50 2.98 .10 .08	374.2	204° (400°)	60	0.5	18.4	10.7	N.D.	23.5	1.7
367, 0.25g. Al Ag Cu S.S. Ti 0.06 .14 2.10 .24 -.02	375.2	232° (450°)	48	6.9	35.8	20.3	N.D.	28.7	4.1
367 0.25g. Al Ag Cu S.S. Ti 0.20 .32 1.60 .00 .04	379.2	260° (500°)	36	8.7	156.3	108.2	N.D.	24.1	8.6
Di-2-naphthylamine, No. 383, 0.25g. Al Ag Cu S.S. Ti 0.24 .30 1.24 .36 .14	374.3	204° (400°)	60	1.1	21.4	14.9	N.D.	12.7	1.9
383 0.30g. Al Ag Cu S.S. Ti 0.16 .38 .82 .02 .24	365.7	204° (400°)	60	3.3	25.6	17.0	N.D.	7.4	2.4
383 0.30g. Al Ag Cu Cr-Mo Ti 0.20 .50.76 .08 .28	365.8	204° (400°)	60	2.5	24.8	16.5	N.D.	5.4	2.3

N.D. Not Determined.

Table 13. Oxidations in a Pentaerythritol Ester, MLO 55-584 (Cont'd)

Sample 25 ml., Air Flow 1 l/Hr.

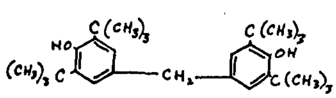
Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C* (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
Di-2-naphthylamine, No. 383, 0.25g. Al Ag Cu S.S. Ti 0.12 .30 1.32 .10 .00	375.3	232° (450°)	48	6.0	25.0	14.7	N.D.	33.1	3.6
383 0.25g. Al Ag Cu S.S. Ti 0.14 .42 1.78 .02 .06	379.3	260° (500°)	36	9.1	75.4	59.8	N.D.	30.1	5.2
383 0.30g. No Metals	367.3	260° (500°)	48	5.8	49.5	35.3	N.D.	24.3	4.8
383 0.30g. Al Ag Cu S.S. Ti 0.02 .14 1.32 -.12 -.20	367.4	260° (500°)	48	7.4	27.8	19.3	N.D.	28.7	2.8
									
Age Rite Stalite, No. 389, 0.25g. Al Ag Cu S.S. Ti 0.22 .34 2.74 .16 .12	374.8	204° (400°)	60	0.9	24.4	14.9	N.D.	24.4	0.3
389 0.25g. Al Ag Cu S.S. Ti 0.28 .36 2.52 .06 .18	375.8	232° (450°)	48	6.1	53.0	36.1	N.D.	30.3	3.0
389 0.25g. Al Ag Cu S.S. Ti 0.04 .14 1.76 .32 .00	379.8	260° (500°)	36	7.3	50.4	33.5	N.D.	32.8	3.2
Age Rite H.P., No. 388, 0.25g. Al Ag Cu S.S. Ti 0.20 .40 .50 .12 .10	374.7	204° (400°)	60	0.6	14.1	8.9	N.D.	1.5	1.0
388, 0.25g. Al Ag Cu S.S. Ti 0.42 .74 1.34 .06 .14	375.8	232° (450°)	48	5.4	22.4	13.1	N.D.	21.2	3.3
388, 0.25g. Al Ag Cu S.S. Ti 0.18 .24 1.52 .18 .00	379.7	260° (500°)	36	8.1	42.3	32.0	N.D.	32.9	4.4
388, 0.25g. Al Ag Cu S.S. Ti 0.14 .44 .92 .04 .02	380.7	260° (500°)	36	3.7	33.5	24.0	N.D.	28.9	2.9
Age Rite Hipar, No. 387, 0.25g. Al Ag Cu S.S. Ti 0.20 .30 .66 .26 .20	374.6	204° (400°)	60	0.0	16.1	11.5	N.D.	2.2	0.8
387 0.25g. Al Ag Cu S.S. Ti 0.00 .30 1.22 .30 .40	375.6	232° (450°)	48	6.9	20.5	12.8	N.D.	12.8	2.9
387 0.25g. Al Ag Cu S.S. Ti 0.02 .08 1.14 .10 .00	379.6	260° (500°)	36	8.9	67.3	54.2	N.D.	25.5	4.9
Age Rite Resin-D, No. 385, 0.25g. Al Ag Cu S.S. Ti 0.24 .50 1.22 .26 .26	374.4	204° (400°)	60	1.5	17.2	11.3	N.D.	6.9	1.8
385 0.25g. Al Ag Cu S.S. Ti 0.14 .22 .48 .18 .18	375.4	232° (450°)	48	5.0	25.4	15.4	N.D.	31.9	2.8
385 0.25g. Al Ag Cu S.S. Ti 0.10 .50 .54 .18 -.06	379.4	260° (500°)	36	8.3	29.6	15.4	N.D.	32.2	3.4
Age Rite Resin, No. 386, 0.25g. Al Ag Cu S.S. Ti 0.14 .42 1.82 .34 .16	374.5	204° (400°)	60	2.2	69.0	48.7	N.D.	26.4	6.0
386 0.25g. Al Ag Cu S.S. Ti 0.12 .36 .74 .02 .18	375.5	232° (450°)	48	5.4	67.5	49.8	N.D.	25.9	6.5
386 0.25g. Al Ag Cu S.S. Ti 0.10 .20 .60 .12 .02	379.5	260° (500°)	36	10.0	221.5	159.0	N.D.	25.0	9.7

N.D. Not Determined.

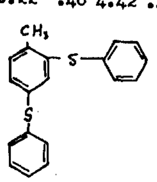
Table 13. Oxidations in a Pentaerythritol Ester, MLO 55-584 (Cont'd)

Sample 25 ml. Air Flow: 1 l/Hr.

Additive, CCL No., Formula, Concentration, Metals Present	Run No.	Temp. °C (°F)	Time, Hours	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C * (130°F)	100°C (212°F)	195°C (383°F)	Neutralization Number	Iso-octane Insoluble, %
N-Aminoethylmorpholine, No. 117, 0.10g. and p-Aminodiphenylamine, No. 360, 0.12g. Al Ag Cu S.S. Ti 0.16 .58 .26 .12 .00	391.9	204° (400°)	60	5.9	22.2	16.2	N.D.	5.1	N.F.
N-Aminoethylmorpholine, No. 117, 0.10g. and 2,2'-dipyridylamine, No. 128, 0.11g. Al Ag Cu S.S. Ti 0.10 .34 .28 .04 .08	391.10	204° (400°)	60	4.6	7.2	4.8	N.D.	1.5	0.4
N,N'-Diphenyl-p-phenylenediamine, No. 186, 0.17g. and 4,4'-bisthiopicolinamido diphenyl, No. 401, 0.03g. Al Ag Cu S.S. Ti -0.10 -.04 -.18 -.06 -.14 .04 .20 .38 .20 .12	422.7	204° (400°)	60	7.1	14.8	9.7	N.D.	4.1	1.2
186 0.17g. and 401, 0.03g. Al Ag Cu S.S. Ti -0.28 -.22 -.06 -.06 -.08 .26 .34 .30 .08 .08	422.8	204° (400°)	60	6.1	11.0	7.7	N.D.	3.0	0.8
Vanadyl-2-ethyl hexoate, No. 379, 0.25g. Al Ag Cu S.S. Ti 0.24 .20 1.48 .64 .02	362.3	204° (400°)	60	3.5	36.7	25.7	N.D.	72.9	6.5
4,4'-Methylene-bis-2,6-ditertiary butyl phenol, No. 370, 0.30g. Al Ag Cu S.S. Ti 0.00 .10 1.52 -.34 -.20	367.9	260° (500°)	48	7.5	71.3	52.4	N.D.	28.3	11.2



1,4,2-Benzoselenazin-3-one, No. 308, 0.30g. Al Ag Cu S.S. Ti -0.14 2.92 11.7 .66 .00	367.10	260° (500°)	48	5.4	57.3	42.6	N.D.	28.6	11.8
2,4-Bis-(phenyl mercapto) toluene, No. 372, 0.25g. Al Ag Cu S.S. Ti 0.22 .46 4.42 .18 .04	362.5	204° (400°)	60	4.7	59.5	39.9	N.D.	22.1	3.2

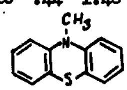
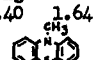
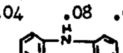
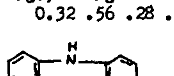


N.D. Not Determined.
N.F. Not Filterable.

TABLE 14

Oxidations in Bis-(2-ethylhexyl) Sebacate

25 ml Sample   Air Flow 1 L/Hr.

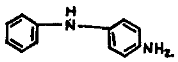
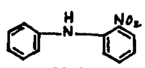
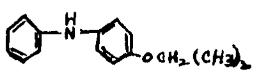
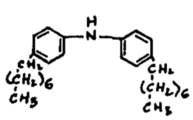
Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage: Isooctane Wash	Insoluble Percentage: Isooctane Precipitate
N-Methylphenothiazine, No. 5, 0.26 g., No Metals	393.2	60	204° (400°)	1.6	5.4	3.9	4.2	1.1	1.5
5, 0.27g. Al Ag Cu S.S. Ti 0.44 .48 1.70 .24 .02	363.1	60	204° (400°)	2.8	10.6	6.6	13.0	N.D.	2.7
5, 0.27g. Al Ag Cu Cr-Mo. Ti 0.26 .44 1.48 .82 .28	363.2	60	204° (400°)	4.7	12.7	7.0	14.3	N.D.	2.6
									
N-Methylphenothiazine, No.5, 0.20g., and Vanadyl-2-ethyl hexoate, No. 379, 0.07g. Al Ag Cu Cr-Mo Ti 0.48 .34 2.06 1.94 .20	363.6	60	204° (400°)	7.0	82.0	62.8	32.2	N.D.	7.7
5, 0.15 g. and Ferroscene, No. 373, 0.07g. Al Ag Cu S.S. Ti 0.00 .02 1.14 .08 .10	365.5	60	204° (400°)	3.4	16.9	10.0	24.1	N.D.	1.3
5, 0.20g., 373, 0.07g. Al Ag Cu Cr-Mo Ti 0.30 .40 1.64 .32 .28	363.7	60	204° (400°)	2.9	10.0	5.6	10.4	N.D.	2.7
									
Diphenylamine, No. 52, 0.22g. No Metals	419.6	60	204° (400°)	2.7	33.5	7.7	15.0	0.02	1.7
52, 0.22g. Al Ag Cu S.S. Ti -0.18 -.30 .20 .14 -.12 .26 .38 .42 .20 .22	413.4	60	204° (400°)	4.9	18.9	12.4	14.6	1.1	1.8
52, 0.44g. Al Ag Cu S.S. Ti -0.02 .10 .40 .12 .00 .16 .28 .40 .14 .16	419.4	60	204° (400°)	4.8	20.4	13.8	8.2	1.5	3.4
52, 0.22g. Al Ag Cu S.S. Ti 0.08 .00 .68 .16 .06 .02 .02 .00 .00 .06	414.4	48	260° (500°)	8.0	790.0	432.0	14.7	14.0	4.2
52, 0.44g. Al Ag Cu S.S. Ti 0.32 0.22 1.24 0.22 0.04	416.9	48	260° (500°)	6.7	33.4	25.3	16.3	N.F.	N.F.
.04 .02 .06 .06 .04 Al Ag Cu S.S. Ti 0.32 .14 .58 .28 .16 .10 .04 .08 .02 .02	417.2 a/	60	204° (400°)	5.6	23.4	14.7	15.0	1.8	2.5
									
p-Aminodiphenylamine, No. 360 0.24g., Al Ag Cu S.S. Ti 0.20 .28 .26 .04 .02	389.7	60	204° (400°)	2.5	16.3	10.7	14.1	1.3	1.0
360 0.24g.,Al Ag Cu S.S. Ti 0.16 .50 .22 .06 .12	391.5	60	204° (400°)	6.8	19.5	13.3	14.4	0.8	1.1
360 0.24g.,Al Ag Cu S.S. Ti -0.20 .04 .04 -.06 -.10 .22 .20 .14 .14 .08	413.3	60	204° (400°)	5.1	16.1	10.5	10.5	0.5	1.0
360 0.25g.,Al Ag Cu S.S. Ti 0.34 .40 .46 .24 .08	362.10	60	204° (400°)	1.8	9.6	5.8	11.9	N.D.	2.1
360 0.25g.,Al Ag Cu S.S. Ti 0.32 .56 .28 .24 .20	363.3	60	204° (400°)	4.4	11.6	7.6	9.5	N.D.	2.1
									

N.D. Not Determined.

N.F. Not Filterable.

a/ Check Run on 413.4 to show metal effects.

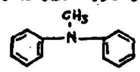
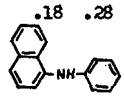
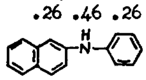
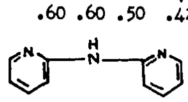
Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	25 ml Sample Neutralization No.	Air Flow 1 L/Hr. Insoluble Isooctane Wash	Percentage Isooctane Precipitate
p-Aminodiphenylamine, No. 360, 0.25g. Al Ag Cu Cr-Mo Ti 0.30 .50 .46 .30 .26	363.4	60	204° (400°)	2.7	12.7	9.1	11.5	N.D.	2.2
360,0.25g. Al Ag Cu S.S. Ti 0.10 .24 .50 .26 .00	373.10	48	232° (450°)	2.1	10.9	6.1	21.6	N.D.	
360,0.24g. Al Ag Cu S.S. Ti 0.30 .52 .52 .24 .16	390.7	24	260° (500°)	3.1	10.1	5.9	18.6	2.5	1.7
360,0.25g. Al Ag Cu S.S. Ti 0.16 1.12 .80 .58 .30	381.5	36	260° (500°)	4.0	9.0	5.5	16.3	N.D.	3.3
360 0.25g. Al Ag Cu S.S. Ti 0.28 .94 1.08 1.02 .08	381.6	48	260° (500°)	5.0	12.1	7.4	16.4	N.D.	4.1
360 0.25g. Al Ag Cu S.S. Ti -0.06 .10 .56 .52 -.18 .22 .28 .20 .18 .16	414.3	48	260° (500°)	6.0	16.4	9.7	15.5	3.8	0.9
									
2-Nitrodiphenylamine, No.87, 0.25g. No Metals	394.1	60	204° (400°)	2.2	23.7	15.6	21.9	0.2	2.0
87,0.25g. Al Ag Cu S.S. Ti -0.26 .02 .22 -.12 -.08 .40 .38 .52 .18 .14	415.10	60	204° (400°)	5.4	14.3	9.4	15.3	0.1	1.1
87,0.25g. Al Ag Cu S.S. Ti -0.16 .12 .32 .16 .08 .10 .06 .14 .04 .00	417.1	60	204° (400°)	5.4	15.8	10.4	19.3	0.2	1.0
87,0.50g. Al Ag Cu S.S. Ti -0.28 -.32 -.02 -.20 -.10 .36 .36 .40 .30 .24	419.3	60	204° (400°)	8.7	18.8	11.1	16.7	0.4	1.3
87,0.25g. Al Ag Cu S.S. Ti 0.16 .12 1.12 .46 -.32 .08 .06 .06 .10 .10	416.10	48	260° (500°)	6.9	24.0	18.5	18.3	N.F.	N.F.
									
p-Isopropoxydiphenylamine, No. 390, 0.25g. Al Ag Cu S.S. Ti 0.42 .44 .80 .24 .18	372.9	60	204° (400°)	6.2	17.2	11.7	20.9	N.D.	2.0
390,0.25g. Al Ag Cu S.S. Ti 0.00 .32 2.08 .30 .00	373.9	48	232° (450°)	2.4	23.3	17.6	18.9	N.D.	3.5
390,0.25g. Al Ag Cu S.S. Ti 0.14 .08 .94 .02 .00	378.9	36	260° (500°)	2.6	81.5	66.2	20.9	N.D.	8.2
									
p,p'-Dioctyldiphenylamine, No.22, 0.49g. Al Ag Cu S.S. Ti 0.10 .16 2.24 .02 .14 .04 .00 .04 .04 .02	415.8	60	204° (400°)	4.7	31.5	32.7	8.5	0.04	5.7
22,0.49g. Al Ag Cu S.S. Ti 0.14 .06 2.92 .64 .10 .02 .08 .06 .02 .04	416.8	48	260° (500°)	6.3	54.5	39.8	15.4	0.06	9.5
22,1.0g. Al Ag Cu S.S. Ti 0.64 .48 .14 .18 .42 .14 .04 .26 .18 .04	417.3	48	260° (500°)	4.8	43.5	18.4	7.7	0.05	0.6
									

N.D. Not Determined.
N.F. Not Filterable.

Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

25 ml Sample Air Flow 1 L/Hr.

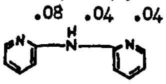
Additive, CCL No., Concentration Metals Present and Weight Loss, mg/cm2	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Isooctane Wash	Percentage Isooctane Precipitate
N-Methylphenylamine, No. 89, 0.23g., No Metals	394.3	60	204° (400°)	2.5	23.7	15.4	16.0	0.10	5.4
89,0.24g. Al Ag Cu S.S. Ti 0.16 .14 -.04 -.24 -.16 .22 .26 .38 .22 .18	415.6	60	204° (400°)	4.8	21.6	13.3	17.5	0.2	2.5
89,0.24g. Al Ag Cu S.S. Ti -0.16 .14 .88 .34 .12 .02 .10 .06 .00 .04	416.6	48	260° (500°)	7.4	121.5	98.5	17.0	0.3	9.4
									
Triphenylamine, No. 88, 0.31g. No Metals	394.2	60	204° (400°)	4.8	62.2	39.6	22.5	0.1	4.0
88,0.31g. Al Ag Cu S.S. Ti 0.06 .00 6.36 .04 .02 .22 .26 .38 .22 .18	415.7	60	204° (400°)	4.3	58.7	44.1	12.0	0.1	0.3
88,0.31g. Al Ag Cu S.S. Ti 0.12 .02 .80 .22 .08 .02 .00 .02 .02 .00	416.7	48	260°	7.8	48.0	23.4	20.4	0.07	5.4
$(C_6H_5)_3N$									
Phenyl-alpha-naphthylamine, No. 61, 0.28g., No Metals	393.7	60	204° (400°)	1.1	27.9	17.7	18.8	0.3	2.5
61,0.28g. Al Ag Cu S.S. Ti 0.04 .02 .28 .00 .06 .04 .16 .20 .06 .04	415.4	60	204° (400°)	3.4	25.3	16.2	17.1	0.4	2.4
61,0.28g. Al Ag Cu S.S. Ti 0.20 .02 .72 .12 -.06 .18 .28 .16 .26 .26	416.4	48	260° (500°)	6.3	24.9	18.7	14.8	0.3	14.4
									
N-Phenyl-2-naphthylamine, No. 140, 0.29g., No Metals	393.8	60	204° (400°)	2.0	31.5	19.1	20.2	0.4	2.8
140,0.28g. Al Ag Cu S.S. Ti -0.02 -.10 .16 -.10 -.10 .12 .16 .32 .14 .10	415.5	60	204° (400°)	3.6	22.4	15.5	19.1	0.2	1.7
140,0.28g. Al Ag Cu S.S. Ti 0.04 .06 .10 -.16 .00 .16 .06 .42 .18 .12	417.7	60	204° (400°)	3.5	20.8	15.8	11.9	0.2	1.6
140,0.28g., Al Ag Cu S.S. Ti 0.04 -.12 .86 .16 .02 .26 .46 .26 .12 .20	416.5	48	260° (500°)	7.5	46.5	32.4	14.9	N.F.	N.F.
									
2,2'-Dipyridylamine, No. 128, 0.22g. No Metals	389.9s	60	204° (400°)	4.1	24.7	16.2	18.9	0.09	0.9
128,0.22g. No Metals	394.8s	60	204° (400°)	3.6	27.0	16.2	17.6	0.1	1.9
128,0.22g. Cu washer 0.88	389.8s	60	204° (400°)	2.8	5.6	2.7	17.0	2.6	0.3
128,0.22g. No Metals	399.7s	60	204° (400°)	4.3	28.9	18.9	15.7	0.1	2.1
128,0.22g. Cu Washer 0.00	401.5s	60	204° (400°)	2.7	8.7	5.8	17.2	0.4	0.02
128,0.22g. Al Ag Cu S.S. Ti -0.58 -.50 -.32 -.42 -.44 .60 .60 .50 .42 .34	413.5s	60	204° (400°)	3.6	11.0	6.7	15.8	2.2	0.4
									

N.F. Non Filterable.

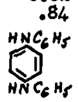
Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

25 ml Sample Air Flow 1 L/Hr.

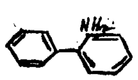
Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
2,2'-Dipyridylamine, No. 128, (Cont'd) 0.25g. No Metals	386.5s	24	260° (500°)	3.7	17.7	11.8	15.7	0.06	4.6
128,0.22g.,No Metals	390.9s	24	260° (500°)	6.2	25.7	18.2	18.8	0.09	0.9
128,0.25g., Cu Washer 1.96	386.6s	24	260° (500°)	3.7	18.4	13.5	18.3	2.6	4.1
128,0.22g., Cu Washer 1.10	390.8s	24	260° (500°)	4.1	11.0	6.1	19.0	2.7	0.7
128,0.25g.Al Ag S.S. Ti 0.52 .72 1.40 .28	386.4s	24	260° (500°)	3.4	65.2	57.6	19.8	0.5	4.3
128,0.22g.Al Ag Cu S.S. Ti 0.34 1.14 3.70 1.70 .40 .08 .04 .04 .12 .02	414.5	48	260° (500°)	6.0	15.4	10.6	15.0	5.1	0.4



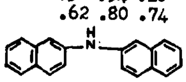
Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
N,N'-Diphenyl-p-phenylene-diamine, No. 186, 0.33g. Recryst. E.K. Blue Label No Metals	407.5	60	204°C (400°C)	1.2	12.3	8.8	9.4	0.2	0.9
186,0.34g. No Metals	419.9	60	204° (400°)	1.7	12.1	2.7	5.9	0.4	1.5
186,0.34g.Al Ag Cu S.S. Ti -0.40-.32 .16 -.12 -.22 .22 .30 .36 .16 .22	422.2	60	204° (400°)	8.3	29.2	20.3	18.1	0.7	1.9
186,0.34g.Al Ag Cu S.S. Ti 0.12 .16 .38 .24 .10 .18 .08 .16 .06 .00	417.4	60	204° (400°)	5.5	9.4	8.5	5.1	0.1	2.0
186,0.34g.Al Ag Cu S.S. Ti -0.40-.24-.20 .00 -.20 .32 .22 .20 .00 .26	422.1	60	204° (400°)	6.4	8.8	6.2	4.9	0.7	0.7
186,0.34g.Al Ag Cu S.S. Ti -0.62-.22-.06 .14 -.24 .84 1.02 1.02 .80 .54	416.2	48	260° (500°)	7.3	19.5	14.1	14.3	1.5	1.7



Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
o-Aminodiphenyl,No. 367,0.25g. Al Ag Cu S.S. Ti 0.20 .28 1.42 .02 .04	372.2	60	204° (400°)	4.0	14.1	8.5	19.2	N.D.	2.3
367,0.25g.Al Ag Cu S.S. Ti 0.32 .64 2.66 .56 .34	373.2	48	232° (450°)	3.0	24.4	17.8	17.5	N.D.	4.1
367,0.25g.Al Ag Cu S.S. Ti 0.22 .38 1.20 .34 .18	378.2	36	260° (500°)	2.2	30.7	19.7	18.0	N.D.	6.3



Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
Di-2-naphthylamine, No. 383, 0.34g. Al Ag Cu S.S. Ti -0.04 -.16 .50 -.04 .00 .16 .12 .12 .04 .04	415.3	60	204° (400°)	5.1	25.8	16.7	19.8	0.4	2.8
383,0.34g.Al Ag Cu S.S. Ti -0.38-.54 .10 -.20 -.48 .62 .80 .74 .46 .60	416.3	48	260° (500°)	7.1	24.9	18.7	16.7	N.F.	N.F.



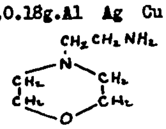
Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
Age Rite Stalite H, No. 389 0.25g. Al Ag Cu S.S. Ti 0.20 .34 4.42 .22 .20	372.8	60	204° (400°)	3.2	29.0	19.1	19.2	N.D.	2.1
389,0.25g. Al Ag Cu S.S. Ti 0.16 .20 1.42 .36 .06	373.8	48	232° (450°)	2.0	32.8	21.7	21.0	N.D.	1.6
389,0.25g.Al Ag Cu S.S. Ti 0.06 .24 .42 .22 .12	378.8	36	260° (500°)	3.1	30.0	18.8	21.3	N.D.	1.5

N.D. Not Determined.
N.F. Not Filterable.

Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

25 ml Sample Air Flow 1 L/Hr.

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	100°	Neutralization No.	Insoluble Percentage Isooctane Wash	Isooctane Precipitate
Age Rite H.P., No. 388, 0.25g. Al Ag Cu S.S. Ti 0.20 .38 1.10 .34 .20	372.7	60	204°C (400°F)	2.5	12.9	7.9	16.0	N.D.	2.0
388,0.25g.Al Ag Cu S.S. Ti 0.04 .18 .72 .20 .06	373.7	48	232° (450°)	2.8	13.4	8.7	16.7	N.D.	3.3
388,0.25g.Al Ag Cu S.S. Ti 0.16 .18 .74 .26 .10	378.7	36	260° (500°)	1.6	21.4	14.1	15.8	N.D.	5.7
388,0.25g.Al Ag Cu S.S. Ti 0.40 .36 1.32 .46 .20	380.4	36	260° (500°)	4.8	23.4	17.6	18.3	N.D.	3.4
Age Rite Hipar, No. 387, 0.25g. Al Ag Cu S.S. Ti 0.08 .10 .42 .08 .00	372.6	60	204° (400°)	3.1	14.3	10.3	15.4	N.D.	1.8
387,0.25g.Al Ag Cu S.S. Ti 0.16 .44 .56 .24 .00	373.6	48	232° (450°)	2.9	13.0	8.2	19.1	N.D.	3.2
387,0.25g.Al Ag Cu S.S. Ti 0.32 .30 1.06 .42 .14	378.6	36	260° (500°)	2.8	22.4	15.6	17.2	N.D.	5.8
Age Rite Resin D., No. 385, 0.25g. Al Ag Cu S.S. Ti 0.28 .38 .68 .02 .00	372.4	60	204° (400°)	4.2	28.2	20.3	20.4	N.D.	2.7
385,0.25g.Al Ag Cu S.S. Ti 0.36 .46 .54 .26 .10	373.4	48	232° (450°)	2.0	24.4	18.8	20.2	N.D.	3.5
385,0.25g.Al Ag Cu S.S. Ti 0.14 .30 .40 .34 .04	378.4	36	260° (500°)	2.6	17.9	13.5	19.4	N.D.	4.4
Age Rite Resin, No. 386 0.25g. Al Ag Cu S.S. Ti 0.30 .30 1.76 .12 .00	372.5	60	204° (400°)	11.2	N.M.	N.M.	22.4	N.D.	6.6
386,0.25g.Al Ag Cu S.S. Ti 0.28 .32 .78 .16 .24	373.5	48	232° (450°)	2.1	56.5	42.5	21.7	N.D.	4.5
386,0.25g.Al Ag Cu S.S. Ti 0.20 .34 .44 .28 .02	378.5	36	260° (500°)	2.1	34.1	21.2	18.1	N.D.	6.2
N-Aminoethylmorpholine, No. 117 0.18g. No Metals	389.4	60	204° (400°)	2.1	33.4	23.2	20.5	0.7	1.4
117,0.18g.Al Ag Cu S.S. Ti 0.30 .42 .48 .10 .06	389.5	60	204° (400°)	3.0	21.6	14.8	19.1	2.7	1.3
117,0.20g.Al Ag Cu S.S. Ti 0.10 .46 .40 .14 .10	391.4	60	204° (400°)	3.6	20.7	14.7	19.7	1.9	1.1
117,0.18g.No Metals	390.4	24	260° (500°)	3.0	22.0	15.9	18.0	0.3	3.6
117,0.18g.Al Ag Cu S.S. Ti	390.5	24	260° (500°)	3.5	16.3	10.9	19.7	N.F.	N.F.



N.D. Not Determined.
N.M. Too viscous for measurement.
N.F. Not Filterable.

Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

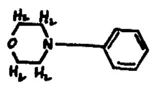
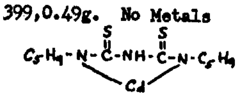
Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	25 ml. Sample Air Flow 1 L/Hr. Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
N-Phenylmorpholine, No. 141, 0.21g., No Metals	395.1	60	204° (400°)	2.5	31.6	21.8	19.8	0.4	2.6
141,0.21g. Al 0.20, Ag .32, Cu .88, S.S. .08, Ti .12	389.6	60	204° (400°)	4.2	28.8	19.1	24.5	1.8	1.9
141,0.21g. Al 0.32, Ag .32, Cu .56, S.S. .28, Ti .28 	390.6	24	260° (500°)	3.7	20.1	14.1	18.1	0.1	4.3
Na Sul-BSN-Barium Sulfonate Neutral Salt in 50% Di-2-ethyl hexyl sebacate, No. 398, 0.60g. No Metals	408.5	60	204° (400°)	7.0	33.8	22.7	34.2	17.5	1.2
398,0.60g. Cu	408.6	60	204° (400°)	8.5	547.0	366.0	7.5	N.F.	6.8
100% Cadmium diamyl dithiocarbamate, No. 399, 0.17 No Metals	410.8	60	204° (400°)	1.6	15.4	11.6	14.4	0.01	2.4
399,0.17g. Al 0.22, Ag .28, Cu 7.26, S.S. .16, Ti .08	410.9	60	204° (400°)	5.0	10.7	7.4	15.9	0.00	2.0
399,0.49g. No Metals 	410.7	60	204° (400°)	1.8	12.5	8.5	12.3	0.03	2.0
4,4'-bisthiopicolinamido diphenyl, No. 401, 0.27g. No Metals	417.8	60	204° (400°)	3.1	14.8	9.4	11.9	0.2	1.4
401,0.27g. No Metals	419.1	60	204° (400°)	4.0	18.3	12.6	14.2	0.6	1.5
401,0.27g.,3 Cu Washers 1.12 0.06 1.04 / .18 1.06 .28	419.2	60	204° (400°)	5.1	20.9	14.4	20.2	0.6	1.2
401,0.27g. 3 Ag 2.50 2.72 4.02 / 2.92 2.26 1.58	417.9	60	204° (400°)	5.3	18.8	12.1	13.6	0.2	1.2
401,0.27g. Al -0.16 / .16, Ag 7.18 / 1.18, Cu .50 / .08, S.S. .00 / .14, Ti -.32 / .34	415.2	60	204° (400°)	5.3	32.8	21.4	23.6	0.5	2.1
Phenothiazine, No. 293,0.25g. and Na Sul BSN (Barium Sulfonate Neutral Salt 50% Dispersion) 0.01g. Al 0.02, Ag -.06, Cu .04, S.S. .00, Ti .04	410.10	60	204° (400°)	3.9	18.2	12.1	16.4	0.6	3.4
Phenothiazine, No. 293,0.125g. and Cadmium Diamyl Dithiocarbamate, (100%), No. 399,0.10g. No Metals	410.3	60	204° (400°)	0.6	4.3	4.9	4.6	0.6	1.5
293 0.125g. and 399 0.05g. Al 0.22, Ag .12, Cu 1.96, S.S. .04, Ti .00	410.5	60	204° (400°)	5.5	16.8	11.2	20.4	0.3	2.6
293 0.25g. and 399 0.05g. Al 0.10, Ag .08, Cu 1.32, S.S. .04, Ti .08	410.6	60	204° (400°)	4.9	13.1	8.8	14.3	0.2	2.8
Phenothiazine, No. 293,0.25g. and 4,4'-bisthiopicolinamido diphenyl, No. 401, 0.01g. Al 0.00 / .10, Ag .04 / .26, Cu .28 / .36, S.S. -.08 / .08, Ti -.14 / .04	423.4	60	204° (400°)	3.1	13.9	8.8	12.6	1.4	2.0
293 0.25g. and 401 0.05g. Al 0.06 / .16, Ag .00 / .10, Cu .34 / .46, S.S. .06 / .08, Ti .02 / .04	417.6	60	204° (400°)	3.2	17.2	15.8	18.6	1.7	1.9

Table 14. Oxidations in Bis-(2-ethylhexyl) Sebacate (Cont'd)

25 ml Sample Air Flow 1 L/Hr.

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Weight Loss, %	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Neutralization No.	Insoluble Percentage Isooctane Wash	Insoluble Percentage Isooctane Precipitate
N,N'-Diphenyl-p-phenylenediamine, No. 186, 0.17g. and 4,4'-bisthiopicolinamide diphenyl, No. 401, 0.01g. Al Ag Cu S.S. Ti 0.14 .02 .54 .08 -.14 .08 .26 .52 .10 ..04	423.2	60	204° (400°)	3.8	24.5	16.4	22.1	1.9	2.1
186 0.17g. and 401 0.03g. Al Ag Cu S.S. Ti 0.36-0.24-.04-.20 -.12 .24 .36 .24 .22 .32	422.4	60	204° (400°)	6.1	14.9	9.7	12.5	0.2	0.8
186 0.17g. and 401 0.03g. Al Ag Cu S.S. Ti 0.06-.08 .30 .06 -.10 .02 .26 .42 .06 .00	423.1	60	204° (400°)	3.2	21.3	14.8	12.1	0.8	2.1
186 0.34g. and 401 0.01g. Al Ag Cu S.S. Ti 0.06-.12 .04 .06 -.14 .04 .20 .20 .04 .02	423.3	60	204° (400°)	12.2	8.3	5.3	5.1	1.8	2.5
186 0.34g. and 401 0.03g. Al Ag Cu S.S. Ti -0.52-.34-.28 -.12 -.12 .32 .38 .50 .20 .12	422.3	60	204° (400°)	8.6	8.1	4.7	4.3	0.6	N.D.
2-Phenylbenzoselenazole, No. 300B, 0.32g. and 4,4'-bisthiopicolinamido, diphenyl, No. 401, 0.05g. Al Ag Cu S.S. Ti 0.02 .30 1.50 .02 .04 .04 .42 .10 .02 .06	415.9	60	204° (400°)	7.3	15.4	9.7	12.1	N.F.	N.F.
300B 0.32g. and 401 0.05g. Al Ag Cu S.S. Ti 0.12 .22 1.22 .16 .06 .06 .08 .12 .00 .02	417.10	60	204° (400°)	8.4	23.6	15.8	26.2	11.8	0.8

TABLE 15

Acid Behavior in an Oxidation of Bis-(2-ethylhexyl) Sebacate at 204°C (400°F)

System	Time, Hours	Total Neutralization No.	Oil Insoluble %	Oil Insoluble Neutralization No.	Oil Filtrate Neutralization No.	Isooctane Wash of Oil Insoluble %	Isooctane Wash of Oil Insoluble Neutralization No.	Isooctane Precipitate %	Isooctane Precipitate Neutralization No.	Oil from Isooctane Filtrate Neutralization No.
No Additive	24	14.9	1.5	10.5	12.9	0.06	47	0.10	50	7.4
No Additive	48	18.9	2.7	17.0	18.1	0.05	64	0.63	40	12.7
No Additive	60	24.8	1.7	19.5	24.4	0.07	48	2.1	57	14.4
0.5% Phenothiazine	24	2.0	2.4	3.0	1.2	0.49	N.D.	0.22	15	1.2
0.5% Phenothiazine	48	2.7	2.8	3.7	2.3	0.61	3.2	0.48	17	2.0
0.5% Phenothiazine	60	5.9	3.0	8.6	5.2	0.77	4.7	0.50	27	3.2
1.0% Phenothiazine	24	2.1	3.3	3.0	1.5	0.93	2.8	0.54	13	1.5
1.0% Phenothiazine	48	3.1	3.7	5.4	2.4	1.2	2.7	0.48	18	1.5
1.0% Phenothiazine	60	3.7	3.8	5.2	2.8	1.3	2.9	0.62	13	1.6
2.0% Phenothiazine	24	2.3	4.0	3.5	1.3	1.9	3.2	1.4	7.2	1.0

TABLE 16

Behavior of Insolubles in Oxidized Bis-(2-ethylhexyl) Sebacate

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Insoluble Percentage: Oil	Insoluble Percentage: Isooctane Wash	Insoluble Percentage: Acetone Wash	Insoluble Percentage: Isooctane Precipitate
None, No Metals	388.1	24	204° (400°)	29.0	15.0	1.22	0.00	0.00	0.10
None, Al Ag Cu S.S. Ti 0.02 0.10 .24 0.00 0.00	388.3	24	204° (400°)	29.8	18.2	1.62	0.00	0.00	0.10
None, No Metals	388.2	48	204° (400°)	50.0	30.0	1.65	0.00	0.00	0.10
None, No Metals	389.1	48	204° (400°)	57.0	37.4	1.15	0.02	0.00	1.76
None, Al Ag Cu S.S. Ti 0.04 .10 .20 .00 .02	388.4	48	204° (400°)	47.2	32.0	2.22	0.04	0.00	2.66
None, No Metals	389.2	60	204° (400°)	58.4	36.6	1.40	0.03	0.00	2.73
None, No Metals	391.1	60	204° (400°)	60.6	38.2	1.23	0.06	0.05	N.D.
None, Al Ag Cu S.S. Ti 0.12 .24 .98 .04 .04	391.2	60	204° (400°)	68.5	45.0	0.78	0.06	0.04	4.23
Phenothiazine, No. 293, 0.125g. No Metal	408.1	60	204° (400°)	7.3	5.0	3.35	0.58	0.48	0.47
293 0.25g., Al Ag Cu S.S. Ti 0.00 .20 .44 .06 -.06	388.6	48	204° (400°)	10.9	7.7	4.92	1.76	1.42	1.37
293 0.25g., No Metals	388.7	60	204° (400°)	6.0	3.9	3.61	1.36	1.07	0.60
293 0.25g., No Metals	388.5	48	204° (400°)	4.9	3.3	3.53	1.16	N.D.	0.43
293 0.25g., No Metals	389.3	60	204° (400°)	8.3	3.2	4.93	1.49	1.20	0.76
293 0.25g., No Metals	399.10	60	204° (400°)	5.1	3.3	2.97	1.28	1.03	0.57
293 0.25g., Al Ag Cu S.S. Ti -0.68 -.76 .06 -0.66 -0.74	408.3	60	204° (400°)	13.6	8.4	2.51	0.33	0.23	1.11
293 0.25g., Al Ag Cu S.S. Ti 0.10 .42 .66 .00 .06	391.3	60	204° (400°)	18.0	11.9	5.63	2.08	1.56	1.23
293 0.25g., No Metals	390.3	24	260° (500°)	18.9	12.5	12.7	5.40	2.56	1.94
293 0.25g., Al Ag Cu S.S. Ti 0.22 .74 .78 .22 .20	383.5	24	260° (500°)	13.5	8.8	6.38	3.00	2.77	0.96
293 0.25g., Al Ag Cu S.S. Ti 0.12 .46 .44 .04 .02	387.2	24	260° (500°)	12.7	8.5	6.40	2.76	2.43	0.97
293 0.25g., Al Ag Cu S.S. Ti 0.10 .42 .82 .02 -.08	384.5	24	260° (500°)	14.9	9.4	6.60	3.25	2.93	0.64
293 0.25g., Al Ag Cu S.S. Ti 0.24 .60 1.46 .18 .00	385.5	48	260° (500°)	33.8	22.4	12.39	9.02	8.79	1.99
P-Aminodiphenylamine, No. 360 0.23g., No Metals	394.5	60	204° (400°)	19.0	13.0	2.70	1.02	0.87	1.04
360 0.23g., No Metals	403.5	60	204° (400°)	15.4	11.2	3.06	0.56	0.36	1.87
360 0.23g., Cu -0.08	403.6	60	204° (400°)	14.1	10.0	4.68	1.01	0.72	2.50
360 0.24g., Al Ag Cu S.S. Ti 0.20 .28 .26 .04 .02	389.7	60	204° (400°)	16.3	10.7	3.42	1.28	1.08	1.00
360 0.24g., Al Ag Cu S.S. Ti 0.16 .50 .22 .06 .12	391.5	60	204° (400°)	19.5	13.3	3.30	0.88	0.74	1.11
360 0.25g., Al Ag Cu S.S. Ti 0.32 .56 .36 .16 .10	372.10	60	204° (400°)	19.6	13.6	N.D.			2.46
360 0.25g., Al Ag Cu S.S. Ti 0.10 .24 .50 .26 .00	373.10	48	232° (450°)	10.9	6.1	N.D.			2.96

N.D. Not Determined.

Table 16. Behavior of Insolubles in Oxidized Bis-(2-ethylhexyl) Sebacate (Cont'd)

Additive, CUL No., Concentration Metals Present and Weight Loss, mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Kinematic Viscosity Change, %, 54.5°C	100°C	Insoluble Percentage Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
p-Aminodiphenylamine, No. 360 0.24g., Al Ag Cu S.S. Ti 0.32 .32 .56 .28 .28	390.7	24	260° (500°)	10.1	5.9	7.60	2.53	2.23	1.68
360 0.25g., Al Ag Cu S.S. Ti 0.12 1.02 .52 .22 -.04	381.4	24	260° (500°)	10.5	4.9	N.D.			3.30
360 0.25g., Al Ag Cu S.S. Ti 0.26 .21 .52 .36 .12	380.2	36	260° (500°)	17.0	9.9	N.D.			2.91
360 0.25g., Al Ag Cu S.S. Ti 0.24 1.10 .66 .70 .02	378.10	36	260° (500°)	7.7	4.9	N.D.			4.48
360 0.25g., Al Ag Cu S.S. Ti 0.16 1.12 .80 .58 .30	381.5	36	260° (500°)	9.0	5.5	N.D.			3.12
360 0.50g., Al Ag Cu S.S. Ti 0.36 1.20 1.14 .96 .26	380.3	36	260° (500°)	7.8	4.6	N.D.			3.09
360 0.50g., Al Ag Cu S.S. Ti 0.22 1.54 .86 .96 .10	381.7	36	260° (500°)	8.1	4.2	N.D.			2.77
360 0.25g., Al Ag Cu S.S. Ti 0.28 .94 1.08 1.02 .08	381.6	48	260° (500°)	12.1	7.4	N.D.			4.42
Di-2-naphthylamine, No. 383, 0.25g., Al Ag Cu S.S. Ti 0.14 .24 1.02 .18 .16	372.3	60	204° (400°)	16.8	9.9	N.D.			2.93
383 0.34g., No Metals	395.10	60	204° (400°)	28.4	18.8	2.40	0.62	0.12	2.24
383 0.34g., No Metals	403.1	60	204° (400°)	24.4	17.3	1.73	1.20	0.00	2.99
383 0.34g., Cu 0.58	403.2	60	204° (400°)	20.0	13.2	2.74	0.47	0.25	3.54
383 0.25g., Al Ag Cu S.S. Ti 0.22 .32 1.34 .46 .16	373.3	48	232° (450°)	21.1	14.2	N.D.			3.50
383 0.25g., Al Ag Cu S.S. Ti 0.20 .64 1.28 .24 .02	378.3	36	260° (500°)	33.6	23.2	N.D.			7.50
Phenothiazine, No. 293, 0.12g., N-aminoethylmorpholine, No. 117, 0.12g. Al Ag Cu S.S. Ti 0.04 .58 .56 .24 .08	386.7	24	260° (500°)	10.5	6.5	5.33	2.60	2.38	0.57
293 0.12g., 117 0.12g. Al Ag S.S. Ti 0.22 .50 .30 .06	386.8	24	260° (500°)	22.8	14.8	11.2	2.66	2.31	0.79
293 0.25g., 117 5 drops Al Ag Cu S.S. Ti 0.30 .98 .80 .38 .16	383.6	24	260° (500°)	7.2	4.1	7.44	4.11	3.66	0.48
293 0.25g., 117 5 drops Al Ag Cu S.S. Ti 0.10 .40 .38 .08 .00	384.6	24	260° (500°)	4.1	2.4	6.87	3.58	2.68	0.35
293 0.25g., 117 5 drops Al Ag Cu S.S. Ti 0.22 1.08 1.22 .50 .44	385.6	48	260° (500°)	10.2	6.5	5.40	2.87	2.60	0.59
Phenothiazine, No. 293, 0.12g., N-Phenylmorpholine, No. 141, 0.12 g. Al Ag Cu S.S. Ti 0.42 1.06 1.04 .60 .50	383.7	24	260° (500°)	10.0	5.9	4.75	2.38	2.87	0.76
293 0.12g., 141 0.12g. Al Ag Cu S.S. Ti 0.36 .60 .36 .24 .10	384.7	24	260° (500°)	9.1	5.1	4.36	2.19	1.88	0.70
293 0.12g., 141 0.12g. Al Ag Cu S.S. Ti 0.26 .82 1.60 .64 .56	385.7	48	260° (500°)	17.7	10.7	6.43	2.49	2.20	1.49

N.D. Not Determined.

Table 16. Behavior of Insolubles in Oxidized Bis-(2-ethylhexyl) Sebacate (Cont'd)

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Kinematic Viscosity Change,%		Insoluble Percentage			
				54.5°C	100°C	Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
Phenothiazine, No. 293, 0.12g. p-Aminodiphenylamine, No. 360, 0.12g., Al Ag Cu S.S. Ti 0.38 .76 .68 .28 .04	382.4	24	260° (500°)	11.4	5.2	1.84	2.31	2.02	2.37
Phenothiazine, No. 293, 0.10g., p-Aminodiphenylamine, No. 360, 0.10g., N-Aminoethylmorpholine, No. 117, 5 drops Al Ag Cu S.S. Ti 0.02 .34 .08 .00 .02	388.9	60	204° (400°)	5.5	4.1	3.16	0.89	0.69	0.55
293 0.10g., 360 0.10g., 117 5 drops, No Metals	387.3	24	260° (500°)	24.7	15.3	10.06	3.46	2.98	0.74
293 0.10g., 360 0.10g., 117 5 drops Al Ag Cu S.S. Ti 0.04 .66 .60 .16 .00	387.4	24	260° (500°)	6.3	3.8	7.53	0.38	2.75	0.36
Phenothiazine, No. 293, 0.10g., p-Aminodiphenylamine, No. 360, 0.05g., 2,2'-Dipyridylamine, No. 128, 0.05g., and N-aminoethylmorpholine, No. 117, 5 drops Al Ag Cu S.S. Ti 0.04 .18 .06 .06 -.18	388.10	60	204° (400°)	5.8	3.9	4.45	1.14	0.92	0.71
293 0.10g., 360 0.05g., 128 0.05g., 117 5 drops No Metals	387.5	24	260° (500°)	14.5	10.3	6.04	2.76	2.46	0.57
293 0.10, 360 0.05, 128 0.05, 117 5 drops Al Ag Cu S.S. Ti 0.12 .64 .58 .30 .00	387.6	24	260° (500°)	5.0	2.7	5.34	2.59	2.41	0.35
Phenothiazine, No. 293, 0.05g., p-Aminodiphenylamine, No. 360, 0.05g., 2,2'-Dipyridylamine, No. 128 0.05g., N-Phenylmorpholine, No. 141 0.05g. Al Ag Cu S.S. Ti 0.00 .34 .38 .12 -.06	387.7	24	260° (500°)	20.5	15.5	11.12	3.85	3.03	1.15
293 0.05g., 360 0.05g., 128 0.05g., 141 0.05g., 117 5 drops Al Ag Cu S.S. Ti 0.06 .36 .28 .04 .04	387.8	24	260° (500°)	7.4	4.4	7.58	3.30	3.00	0.63
Phenothiazine, No. 293, 0.12g. Di-2-naphthylamine, No. 383, 0.12g., Al Ag Cu S.S. Ti 0 .06 .60 .80 .02 .24	382.3	24	260° (500°)	20.6	14.5	5.02	1.55	1.28	3.38
293 0.06, 383 0.07, 360 0.12g. Al Ag Cu S.S. Ti 0.12 1.84 .46 .36 .32	382.5	24	260° (500°)	12.8	7.9	5.97	2.44	2.12	10.79
Phenothiazine, No. 293, 0.25g., Di-2-ethylhexyl hydrogen phosphite, No.101, 5 drops Al Ag Cu S.S. Ti 0.04 .28 .74 -.08 .08	382.8	24	260° (500°)	58.0	45.0	Not Filterable			
Phenothiazine, No. 293, 0.125g., Barium Sulfonate Neutral Salt, No. 398, 0.10g. Cu 1.28	407.3	60	204° (400°)	21.2	14.5	4.47	1.22	0.81	1.35
293 0.25g., 398 0.10g. Cu 0.36	407.4	60	204° (400°)	13.5	10.0	2.76	0.41	0.31	1.32
293 0.25g., 398 0.10g. Al Ag Cu S.S. Ti -.64 -.76 .22 -.68 -.82	408.4	60	204° (400°)	12.8	8.8	2.87	0.50	0.38	1.02

Table 16. Behavior of Insolubles in Oxidized Bis-(2-ethylhexyl) Sebacate (Cont'd)

Additive, CCL No., Concentration, Metals Present and Weight Loss, mg/cm²	Run No.	Time Hours	Temperature °C (°F)	Kinematic Viscosity Change, %, 54.5°C	Kinematic Viscosity Change, %, 100°C	Insoluble Percentage: Oil	Insoluble Percentage: Isooctane Wash	Insoluble Percentage: Acetone Wash	Insoluble Percentage: Isooctane Precipitate
Phenothiazine, No. 293, 0.25g. Vanadyl-2-ethyl hexoate, No. 379 0.05g., Al Ag Cu S.S. Ti 0.08 .50 .72 .12 .02	382.6	24	260° (500°)	54.8	39.6	Not Filterable			2.29
Phenothiazine, No. 293, 0.20g. Stannous naphthenate, No. 373, 0.05g., Al Ag Cu S.S. Ti 0.06 .86 .82 .38 .00	382.7	24	260° (500°)	14.1	8.7	6.53	1.75	1.56	1.97
Phenothiazine, No. 293, 0.06g., p-Aminodiphenylamine, No. 360, 0.06g., Vanadyl-2-ethyl hexoate, No. 379, 0.03g., Stannous naphthenate, No. 373, 0.03 g. Di-2-ethylhexyl hydrogen phosphite, No. 101, 5 drops Al Ag Cu S.S. Ti 0.20 1.04 1.72 .92 .46	382.10	24	260° (500°)	13.1	8.2	5.53	1.33	1.16	1.70
p-Aminodiphenylamine, No. 360, 0.12g., n-Aminoethylmorpholine, No. 117, 0.10g. Al Ag Cu S.S. Ti 0.16 .42 .32 .12 .04	391.6	60	204° (400°)	21.5	15.0	3.17	1.10	0.90	1.13
p-Aminodiphenylamine, No. 360, 0.12g., Di-2-naphthylamine, No. 383, 0.12g. No. 117 5 drops. Al Ag Cu S.S. Ti 0.18 1.10 .94 .46 .14	383.9	24	260° (500°)	10.2	4.0	6.87	3.14	2.85	0.60
p-Aminodiphenylamine, No. 360, 0.12g., n-Aminoethylmorpholine, No. 117, 5 drops, Di-2-naphthylamine, No. 383, 0.12g. Al Ag Cu S.S. Ti 0.06 .56 .40 .04 .02	384.9	24	260° (500°)	11.1	5.5	4.88	2.32	2.09	0.74
360 0.12g., 117 5 drops, 383 0.12g. Al Ag Cu S.S. Ti 0 .26 1.34 .82 .52 .00	385.9	48	260° (500°)	12.8	6.6	7.82	3.02	2.76	0.92
p-Aminodiphenylamine, No. 360, 0.05g., Di-2-naphthylamine, No. 383, 0.05g., n-Aminoethylmorpholine, No. 117, 5 drops, 2,2'-Dipyridylamine, No. 128, 0.05g., n-Phenylmorpholine, No.141, 0.05g., Al Ag Cu S.S. Ti 0.10 .30 .36 .06 .00	387.9	24	260° (500°)	13.6	10.6	11.43	3.64	3.18	0.71
N-Aminoethylmorpholine, No. 117, 0.10g., 2,2'-Dipyridylamine, 0.11g. No. 128, Cu 0.22	391.8	60	204° (400°)	20.4	14.7	6.01	3.75	3.12	0.82
117 0.10g., 128 0.11g. Al Ag Cu S.S. Ti 0.18 .48 .64 .14 .22	391.7	60	204° (400°)	19.2	12.7	4.62	2.52	2.01	0.55
Di-2-naphthylamine, No. 383, 0.10g., N-aminoethylmorpholine, No. 117, 5 drops, N-Phenylmorpholine, No. 141, 0.10g. Al Ag Cu S.S. Ti 0.06 .68 .48 .10 .04	387.10	24	260° (500°)	10.8	7.0	8.75	3.18	2.78	0.81
p-Aminodiphenylamine, No. 360, 0.25g., Di-2-ethylhexyl hydrogen phosphite, No. 101, 5 drops Al Ag Cu S.S. Ti 0.30 .28 .66 .48 .06	382.9	24	260° (500°)	22.1	13.0	8.12	2.92	2.54	2.04

Table 16. Behavior of Insolubles in Oxidized Bis-(2-ethylhexyl) Sebacate (Cont'd)

Additive, CCL No., Concentration, Metals Present and Weight Loss mg/cm²	Run No.	Time, Hours	Temperature °C (°F)	Kinematic Viscosity Change, %, 54.5°C	100°C	Insoluble Percentage Oil	Isooctane Wash	Acetone Wash	Isooctane Precipitate
p-Aminodiphenylamine, No. 360, 0.12, Di-2-ethylhexyl hydergen phosphite, No. 101, 5 drops, Di-2-naphthylamine, 0.12g.?No. 383. Al Ag Cu S.S. Ti 0.32 .88 1.22 .72 .10	383.8	24	260° (500°)	12.6	7.0	4.72	1.86	1.58	0.97
p-Aminodiphenylamine, No. 360, 0.12g., Di-2-ethylhexyl hydrogen phosphite, No. 101, 5 drops, Di-2-naphthylamine, 0.12g.,No. 383. Al Ag Cu S.S. Ti 0.02 .10 .84 .22 .00	384.8	24	260° (500°)	13.5	7.3	4.46	1.89	1.64	0.88
360 0.12g., 101 5 drops, 383 0.12g., Al Ag Cu S.S. Ti Al Ag Cu S.S. Ti 0.00 .16 .64 .02 -.28	385.8	48	260° (500°)	45.5	29.3	15.3	3.40	2.51	3.45
p-Aminodiphenylamine, No. 360, 0.10g., Di-2-ethylhexyl hydrogen phosphite, No. 101, 5 drops, Di-2-naphthylamine, No. 383, 0.10g., Stannous naphthenate, No. 373, 0.05g. Al Ag Cu S.S. Ti 0.44 .76 1.24 .82 .44	383.10	24	260° (500°)	11.3	6.1	4.70	1.67	0.98	0.92
360 0.10g., 101, 5 drops, 383 0.10g., 373 0.05g. Al Ag Cu S.S. Ti 0.38 .40 .76 .16 .00	384.10	24	260° (500°)	15.7	9.4	4.77	1.98	1.71	0.95
360 0.10g., 101, 5 drops, 383, 0.10g., 373 0.05g. Al Ag Cu S.S. Ti 0.08 .80 2.28 .64 .12	385.10	48	260° (500°)	19.5	12.7	11.8	2.14	1.81	1.46

APPENDIX II. Code Numbers, Names, Index To Page Numbers and Source of Supply of Additives and Fluids

(Number in parenthesis refers to Part Number of WADC TR 53-293. The number following is the Page Number in the Part).

CCL No.	Compound	Index	Source
3	Phenothiazine	(VII) 36,52,59	Eastman Kodak Co.
5	N-Methylphenothiazine	(VII) 52,55,59 (VIII) 43,47	E. I. duPont de Nemours and Co. CCL Synthesized
6a	Thianthrene	(VII) 37 (VIII) 18	E. I. duPont de Nemours and Co.
10B	Phenazine	(VII) 35	E. I. duPont de Nemours and Co.
16	N-Butyl-p-aminophenol	(VII) 60	E. I. duPont de Nemours and Co.
17	Disalicylalpropylenediamine	(VII) 30	E. I. duPont de Nemours and Co.
18	2',2'-Methylene-bis-(4-methyl-6-t-butylphenol	(VII) 38,53,56,59	American Cyanamid Co.
20	Propyl gallate	(VII) 60	Heyden Chemical Co.
22	p,p'-Dioctyldiphenylamine	(VII) 27,28,42,43,51 (VIII) 16,48	B. F. Goodrich Chemical Co.
23	2,6-Di-t-butyl-4-methylphenol	(VII) 38	Enjay Co., Inc.
44	2,5-Di-tert-butyl-hydroquinone	(VII) 38,59	Tennessee Eastman Co.
52	Diphenylamine	(VII) 27,49 (VIII) 43,47	Eastman Kodak Co.
53	Carbazole	(VII) 34	The Matheson Co.
54	Phenothioxine	(VII) 37 (VIII) 16	The Matheson Co.
57	Acridone	(VII) 34	The Matheson Co.
58	Xanthone	(VII) 37,38,47,50	The Matheson Co.
61	Phenyl-alpha-naphthylamine	(VII) 27,43,49,55,61 (VIII) 17,39,41	Shell Development Co.

CCL No.	Compound	Index	Source
82	Acridine	(VII) 34,35,42,44, 46,49,52,55,65 (VIII) 21,24,26,27,30, 33,37,39,41,42, 49	The Matheson Co.
87	2-Nitrodiphenylamine	(VII) 28 (VIII) 20,48	American Cyanamid Co.
88	Triphenylamine	(VII) 28,43 (VIII) 49	Eastman Kodak Co.
89	N-Methylphenylamine	(VIII) 49	Eastman Kodak Co.
97	Quinizarin	(VII) 38	Eastman Kodak Co.
105	2-Amino-3-methylpyridine	(VII) 32	Reilly Tar and Chemical Co.
106	2-Amino-4-methylpyridine	(VII) 32	Reilly Tar and Chemical Co.
108	1-Cystine	(VIII) 18	Eastman Kodak Co.
112	Triethanolamine	(VII) 29	Eastman Kodak Co.
117	N-Aminoethylmorpholine	(VII) 29 (VIII) 26,27,51,58	Carbide and Carbon Chemical Division Union Carbide and Carbon Corporation
121	N,N'-Di-(p-acetylaminophenyl) urea	(VII) 36	CCL Synthesized
124	Tetraethylthuiram disulfide	(VIII) 19	Monsanto Chemical Co.
128	2,2'-Dipyridylamine	(VII) 32,33,34,42, 44,46,49,51, 55,58,61 (VIII) 17,24,26,31, 33,38,39,42	Reilly Tar and Chemical Co.
132	Phenyl sulfide	(VIII) 16	Eastman Kodak Co.
133	Phenyl sulfoxide	(VII) 37	Eastman Kodak Co.
140	N-Phenyl-2-naphthylamine	(VII) 27 (VIII) 49	Eastman Kodak Co.
141	N-Phenylmorpholine	(VII) 30,45,49 (VIII) 31,34,52	Eastman Kodak Co.

CCL No.	Compound	Index	Source
146	p-Aminoacetamilide	(VII) 30	Eastman Kodak Co.
148	2,2'-Bibenzothiazole	(VII) 37	CCL Synthesized
155	2,2'-Dithiobis-(benzothiazole)	(VIII) 19	Monsanto Chemical Co.
156	4,4'-Thiobis(6-t-butyl-m-cresol)	(VII) 60 (VIII) 19	Monsanto Chemical Co.
159	N,N'-Diphenylthiourea	(VII) 36 (VIII) 20	Monsanto Chemical Co.
160	Piperidinum-1-piperidine carbodithioate	(VIII) 20	Monsanto Chemical Co.
161	Diphenylguanidine	(VII)36,46,49 (VIII)24,26,27,30, 33	Monsanto Chemical Co.
163	N-Cyclohexyl-2-benzo thiazolesulfenamide	(VIII) 19	Monsanto Chemical Co.
164	4,4'-Dithiodimorpholine	(VII) 37 (VIII) 20	Monsanto Chemical Co.
177	Benzimidazole	(VII) 35	Eastman Kodak Co.
182	5-Amino-1-naphthol	(VII) 29,43	Eastman Kodak Co.
186	N,N'-Diphenyl-p-phenylene-diamine	(VII) 43 (VIII) 21,44,50,53	Eastman Kodak Co.
199	2-Amino-4-(p-diphenyl) thiazole	(VIII) 20	Eastman Kodak Co.
207	6-Amino-2-mercaptobenzothiazole	(VIII) 19	Eastman Kodak Co.
208	2-Methylmercaptobenzothiazole	(VIII) 18	Eastman Kodak Co.
211	N-Ethyl-1-naphthylamine	(VII) 29	Eastman Kodak Co.
212	N-Methyl-1-naphthylamine	(VII) 29	Eastman Kodak Co.
213	2-Methylbenzothiazole	(VIII) 17	Eastman Kodak Co.
220	N-Benzoyldiphenylamine	(VII) 29	CCL Synthesized
247	Diphenyl-3-pyridyl phosphate	(VII) 38,54	Southwest Research Institute
250	1,3-Di-n-butyl-2-thiourea	(VII) 36	Eastman Kodak Co.
251	s-Diphenylurea	(VII) 36	Matheson, Coleman and Bell

CCL No.	Compound	Index	Source
254	1,5-Diaminoanthraquinone	(VII) 30	Matheson, Coleman and Bell
255	2,6-Diaminopyridine	(VII) 34	The Matheson Co.
256	2-Quinolinol	(VII) 32	Eastman Kodak Co.
257	8-Quinolinol	(VII) 32	Eastman Kodak Co.
260	N,N'-Di-2-naphthyl-p-phenylene-diamine	(VII) 31,43,45,51,58 (VIII)23,24,25,27,28, 29,35,36,39,41	Eastman Kodak Co.
261	1-Naphthylamine	(VII) 29,48	Eastman Kodak Co.
262	2-Naphthylamine	(VII) 29,49	Eastman Kodak Co.
264	Chrysazin	(VII) 38	General Aniline and Film Corp.
271	Dilauryl selenide	(VIII) 17	California Research Corp.
282PCA PCB	Phenyl selenide	(VII)37,47,48,52,56 (VIII)16,37,38,39	Eastman Kodak Co.
292	2,6-Ditertiary butyl-4-methyl-phenol	(VII) 53,57,60	Tennessee Eastman Co.
293	Phenothiazine (Distilled)	(VII) 36,52,55,59 (VIII)21,52,54,56,57, 58	CCL Synthesized
296	Phenoselenazine	(VII) 53,56	Peninsular ChemResearch, Inc.
299	2-Phenylnaptho(2,1) thiazole	(VIII) 19	Peninsular ChemResearch, Inc.
300B	2-Phenylbenzoselenazole	(VII)37,47,48,53,56 (VIII)17,24,26,27,37, 38,40,54,55	Peninsular ChemResearch, Inc.
303B	o,o'-Dinitrodiphenyl diselenide	(VIII) 19	Peninsular ChemResearch, Inc.
307	Di-(2-hydroxy-1-naphthyl) selenide	(VIII)18,38,40	Peninsular ChemResearch, Inc.
308	1,4,2-Benzoselenazin-3-one	(VII) 53,56 (VIII)38,40,46	Peninsular ChemResearch, Inc.
314	2,2'-Dibiphenyl diselenide	(VIII) 16	Peninsular ChemResearch, Inc.
318	N-Phenyldibenzylamine	(VII) 28	Eastman Organic Chemicals

CCL No.	Compound	Index	Source
319	Dilauryl diselenide	(VII) 48	Peninsural ChemResearch, Inc.
320	Benzyl sulfide	(VIII) 18	Eastman Organic Chemicals
321	Benzyl disulfide	(VIII) 17	Eastman Organic Chemicals
322	Phenyl disulfide	(VIII) 19	Eastman Organic Chemicals
323	Diphenyl diselenide	(VII) 48 (VIII) 17	Eastman Organic Chemicals
324	Morpholine diselenide	(VII) 37,53,56 (VIII) 17	Monsanto Chemical Co.
326	Diphenylguanidine phthalate	(VII) 36	Monsanto Chemical Co.
327	Diphenylguanidine	(VII) 36	Monsanto Chemical Co.
330	Zinc diethyldithiocarbamate	(VII) 47	Monsanto Chemical Co.
332	Thiocarbanilide	(VII) 44,46 (VIII) 36	Monsanto Chemical Co.
340	N,N'-Diphenylbenzidine	(VII) 29,58	Eastman Organic Chemicals
341	N-Phenylphthalimide	(VII) 36,58	Eastman Organic Chemicals
342	1,5-Dihydroxyanthraquinone	(VII) 38,61	Eastman Organic Chemicals
343	p-Hydroxy-p-methylacetanilide	(VII) 51,55,61	Eastman Organic Chemicals
344	N,N'-Ethylenebisbenzamide	(VII) 58	Eastman Organic Chemicals
345	4,4'-Dihydroxybiphenyl	(VII) 61	Eastman Organic Chemicals
348	N,N'-Di-(p-methyl)-p-phenylenediamine	(VII) 31,44	E. I. duPont de Nemours and Co., Jackson Lab.
349	N-Phenyl-N'-(p-methylphenyl)-p-phenylenediamine	(VII) 31	E. I. duPont de Nemours and Co., Jackson Lab.
350	N,N'-Di-(2-methyl-3-chlorophenyl)-p-phenylenediamine	(VII) 32,46,50 (VIII)29,32,36	E. I. duPont de Nemours and Co., Jackson Lab.
351	N,N'-Dicyclohexyl-p-phenylenediamine	(VII) 31 (VIII) 25,27	E. I. DuPont de Nemours and Co., Jackson Lab.

CCL No.	Compound	Index	Source
352	N,N'-Diphenyl-1,4-benzoquinone-diamine	(VII) 32,44	E. I. duPont deNemours and Co.
354	Diphenyl-di-p-biphenylsilane	(VII) 38	Wright Air Development Center
356	Triphenyl-p-phenylsilane	(VII) 39 (VIII) 31	Wright Air Development Center
359	p-Nitrosodiphenylamine	(VII) 28	Hercules Powder Co.
360	p-Aminodiphenylamine	(VII)28,43,45,49 (VIII)26,27,31,32, 34,36,43,44, 47,48,55,56, 58,59	Hercules Powder Co.
365	Triphenylphosphite	(VII) 38,47,50,54 65	Eastman Kodak Co.
367	o-Aminodiphenyl	(VIII) 44,50	Matheson, Coleman and Bell
369	2,6-Di-tert-butyl phenol	(VII)53,56,60	Wright Air Development Center
370	4,4'-Methylene-bis-2,6-ditertiary butyl phenol	(VII) 47,53,56,59 (VIII) 21,46	Wright Air Development Center
371	4-Hydroxy-3,5-di-tert-butyl benzyl dimethylamine	(VII) 45,48,51,55, 58,59 (VIII)18,39,42	Wright Air Development Center
372	2,4-bis-(phenylmercapto) toluene	(VII) 52,56 (VIII) 20,31,34,46	Wright Air Development Center
373	Stannous naphthenate	(VII) 39,47,54,57, 60 (VIII)36	Thermit Corp. Research Laboratory
374	Ferrocene	(VII) 39,47,54,57, 60	Wright Air Development Center
375	Morgan's Base (Dibenzoacridine)	(VII) 35 (VIII) 30,33	CCL Synthesized
377	Thianol	(VII) 60	CCL Synthesized
378	Lithium salt of Thianol	(VII) 60	CCL Synthesized
379	Vanadyl-2-ethyl hexoate	(VIII) 24,46	Wright Air Development Center

CCL No.	Compound	Index	Source
383	Di-2-naphthylamine	(VIII) 24,31,34,44, 45,50,56,58	American Cyanamid Co.
385	Age Rite Resin D (a polymer of trimethyldihydroquinoline)	(VIII) 45,51	B. F. Goodrich Co.
386	Age Rite Resin (a condensation product of aldol and alpha-naphthylamine)	(VIII) 45.51	B. F. Goodrich Co.
387	Age Rite Hipar (50% phenyl-beta-naphthylamine, 20% N,N'-diphenyl-p-phenylenediamine and 30% p-isopropoxydiphenylamine)	(VIII) 45,51	B. F. Goodrich Co.
388	Age Rite H.P. (67% Phenyl-beta-naphthylamine, 33% N,N'-diphenyl-p-phenylenediamine)	(VIII) 45,51	B. F. Goodrich Co.
389	Age Rite Stalite H (Di-octylated-p-phenylenediamine)	(VIII) 45,50	B.F. Goodrich Co.
390	p-Isopropoxydiphenylamine	(VIII) 44,48	B. F. Goodrich Co.
395	Copper sebacate, 2,2'-Dipyridylamine Complex	(VIII) 37	CCL Synthesized
398	Na Sul BSN-Barium Sulfate (Neutral salt in 50% Di-(2-ethylhexyl) sebacate)	(VIII) 52	R. T. Vanderbilt Co,, Inc.
399	Cadmium diamyl dithiocarbamate (100%)	(VIII) 20,52	R. T. Vanderbilt Co., Inc.
401	4,4'-Bisthiopicolinamido diphenyl	(VIII) 21,52	Wright Air Development Center

Fluids

CCL No.	Fluid Medium	Index	Source
2	Bis-(2-ethylhexyl) sebacate	(VII) 59-61 (VIII) 47-59	Rohm and Haas Co. Plexol 201
170	DC Silicone 550	(VII) 43-44	Dow Corning Corp.
298	G.E. Silicone No. 81406 (MLO 53-446)	(VII) 45-47 (VIII)35-36	General Electric Co.
316	Tris-(o-chlorophenyl) phosphate (MLO 9522)	(VII) 62	Southwest Research Institute
336	DC Silicone, XF258 (MLO 9840)	(VII) 26-42 (VIII) 42	Wright Air Development Center
337	Phenyl-o-chlorophenyl phosphate (1:2) (MLO 9579)	(VII) 63	Wright Air Development Center
338	Tris-(chlorophenyl) phosphate (1:1 ortho meta) (MLO 9582)	(VII) 62	Wright Air Development Center
339	Pentaerythritol Ester, Hercules J-19 (MLO 55-584)	(VII) 51-54 (VIII)43-46	Wright Air Development Center
346	Tris-(m-chlorophenyl) phosphate (MLO 9533)	(VII) 64-65	Wright Air Development Center
347	Diphenyl-o-chlorophenyl phosphate (MLO 9574)	(VII) 63-64	Wright Air Development Center
357	Tetrakis-n-dodecyl silane (MLO 54-408D)	(VII) 48-50	Metal and Thermit Co.
366	Bis-(1-methyl cyclohexylmethyl) sebacate (MLO 55-796-1) First Batch (MLO 55-796-2) Second Batch	 (VII) 55 (VII) 55-57	Wright Air Development Center
368	Silane (MLO 56-280)	(VII) 50 (VIII)41-42	Wright Air Development Center
380	Fluid F-60 (First Batch)	(VIII) 22-24	Wright Air Development Center
381	n-Octadecyl-tri-n-octyl silane (MLO 56-578)	(VIII) 39-40	Wright Air Development Center
382	Di-n-dodecyl-di-n-octyl silane (MLO 56-611)	(VIII) 38	Wright Air Development Center
392	Versilube F-50 Silicone	(VIII) 28-32	Wright Air Development Center

CCL No.	Fluid Medium	Index	Source
393	Fluid F-60 (Second Batch)	(VIII) 25-27	Dow Corning Corp.
400	Mineral Oil, MLO 57-30	(VIII) 16-21	Wright Air Development Center
402	Didodecyl dioctyl silane	(VIII) 37	Wright Air Development Center